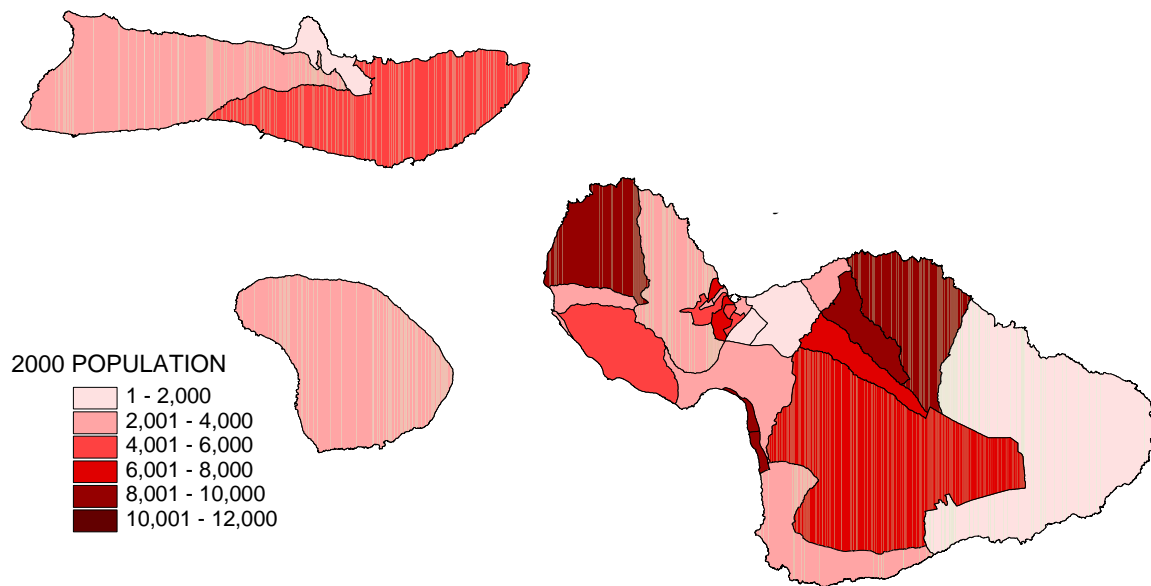


COUNTY OF MAUI INFRASTRUCTURE ASSESSMENT UPDATE



Prepared For: County of Maui
Department of Planning

Prepared By: Wilson Okamoto & Associates, Inc.

May 2003

***County of Maui
Infrastructure Assessment Update***

Prepared for:

***County of Maui
Planning Department***

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CONTENTS

Water Systems

Wastewater Systems

Drainage Systems

Parking Assessment

Electrical Systems

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Water Systems

Prepared for:

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Planning Department***

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May 2003

TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	
I. INTRODUCTION	1
II. ASSESSMENT METHODOLOGY	1
A. Demand and Forecast Methodology.....	2
III. CENTRAL MAUI COMMUNITY PLAN REGIONS.....	4
A. Existing System/Service.....	4
B. Existing Demand	5
1. Wailuku-Kahului	5
2. Kihei-Makena.....	7
C. Existing System Constraints and Opportunities.....	7
D. Future System Service Requirements.....	9
1. Projected Demand	9
2. Future System Requirements and Costs.....	12
IV. WEST MAUI COMMUNITY PLAN REGION.....	16
A. Existing System/Service.....	16
B. Existing Demand	18
C. Existing System Constraints and Opportunities.....	19
D. Future System Service Requirements.....	20
1. Projected Demand	20
2. Future System Requirements and Costs.....	22
V. MAKAWAO-PUKALANI-KULA COMMUNITY PLAN REGION	24
A. Existing System/Service.....	24
B. Existing Demand	26
C. Existing System Constraints and Opportunities.....	26
D. Future System Service Requirements.....	27
1. Projected Demand	27
2. Future System Requirements and Costs.....	29
VI. PAIA-HAIKU COMMUNITY PLAN REGION.....	31
A. Existing System/Service.....	31
B. Existing Demand	31
C. Existing System Constraints and Opportunities.....	31
D. Future System Service Requirements.....	32
1. Projected Demand	32
2. Future System Requirements and Costs.....	32
VII. HANA COMMUNITY PLAN REGION.....	34
A. Existing System/Service.....	34
B. Existing Demand	34

C.	Existing System Constraints and Opportunities	36
D.	Future System Service Requirements.....	36
1.	Projected Demand	36
2.	Future System Requirements and Costs	37
2.	Future System Requirements and Costs	38
VIII.	MOLOKAI COMMUNITY PLAN REGION	39
A.	Existing System/Service.....	39
B.	Existing Demand	39
C.	Existing System Constraints and Opportunities	42
D.	Future System Service Requirements.....	44
1.	Projected Demand	44
2.	Future System Requirements and Costs	45
IX.	LANAI COMMUNITY PLAN REGION.....	48
A.	Existing System/Service.....	48
B.	Existing and Projected Demand	48
C.	System Constraints and Opportunities	50
D.	Future Requirements and Costs.....	51

LIST OF CHARTS

	<u>Page</u>
Chart 1 Wailuku-Kahului Water Demand Projection	10
Chart 2 Kihei-Makena Water Demand Projection	11
Chart 3 West Maui Water Demand Projection.....	21
Chart 4 Makawao-Pukalani-Kula Water Demand Projection	28
Chart 5 Paia-Haiku Water Demand Projection	33
Chart 5 Hana Water Demand Projection	37
Chart 6 Molokai Water Demand Projection.....	46

LIST OF TABLES

	<u>Page</u>
Table 1 Municipal Water Systems	1
Table 2 Central Maui System Sources	4
Table 3 Wailuku-Kahului Water Demand (mgd).....	5
Table 4 Kihei-Makena Water Demands	7
Table 5 Wailuku-Kahului Water Demand Projections.....	10
Table 6 Kihei-Makena Water Demand Projections.....	11
Table 7 Central Maui Water System Proposed Improvements	15
Table 8 Lahaina DWS Sources.....	16
Table 9 West Maui Water Demands (mgd).....	19
Table 10 West Maui Water Demand Projections	21
Table 11 Lahaina Water System Proposed Improvements.....	23
Table 12 Makawao-Pukalani-Kula Sources	26
Table 13 Makawao-Pukalani-Kula Water Demands (mgd)	26
Table 14 Makawao-Pukalani-Kula Water Demand Projections	28
Table 15 Upcountry Water System Proposed Improvements	30
Table 16 Paia-Haiku Sources	31
Table 17 Paia-Haiku Water Demands (mgd)	31
Table 18 Paia-Haiku Water Demand Projections.....	33
Table 19 Hana Sources.....	34
Table 20 Hana Water Demands (mgd).....	36
Table 21 Hana Water Demand Projections	37
Table 22 Hana Water System Proposed Improvements	38
Table 23 Molokai Sources.....	39
Table 24 Molokai Water Demands (mgd).....	42
Table 25 Molokai Working Group Projections	43
Table 26 Molokai Water Demand Projections	46
Table 27 Molokai Water System Proposed Improvements.....	47
Table 28 Lanai Sources	48
Table 29 1995 Use and Projected Demand for Lanai.....	50

LIST OF FIGURES

	<u>Page</u>
Figure 1 Central Maui Water System.....	6
Figure 2 Island of Maui Hydrologic Units	8
Figure 3 West Maui Water System	17
Figure 4 Upcountry Water System.....	25
Figure 5 East Maui Water System.....	35
Figure 6 Molokai Water System	40
Figure 7 Island of Molokai Hydrologic Units	41
Figure 8 Island of Lanai Hydrologic Units.....	49

EXECUTIVE SUMMARY

A. Introduction

This is a summary assessment of the existing water systems within the County of Maui, including Molokai and Lanai, and the Community Plan regions of Wailuku-Kahului, Kihei-Makena, West Maui, Makawao-Pukalani-Kula, Paia-Haiku, and Hana. The focus is on the County's domestic water system and supply, and more specifically on the potable water supply.

In the County of Maui, the Maui Department of Water Supply (DWS) is responsible for the development, operation and maintenance of the municipal water system and supply. In 2002, a Charter Amendment was approved to restructure the DWS as a regular county agency subject to the mayor's executive management oversight (the DWS was previously a semi-autonomous agency).

There are six major water systems in Maui County which comprise the municipal service areas: Central Maui, Lahaina, Makawao, Kula, Hana, and Molokai. Water use in the County DWS system areas was tabulated by land use categories and sub-districts from DWS data through billings and metered consumption. The projected demand for water is based on projections supplied by the *Socio-Economic Forecast Study Update* (SMS, May 2002).

B. Central Maui: Wailuku-Kahului and Kihei-Makena Community Plan Regions

The Wailuku-Kahului and Kihei-Makena Community Plan regions are part of the Central Maui Water System which services the communities of Waihee and Waiehu to the north, Wailuku, Kahului, Paia to the east, and Maalaea-Kihei-Makena to the south.

Approximately 75 percent of the water to supply the Central Maui System is withdrawn from the Iao Aquifer in the vicinity of Iao Stream and Waiehu Stream. The balance of 25 percent is withdrawn from the adjacent Waihee Aquifer to the northwest.

The Waihee Aquifer was tapped with the North Waihee well development, with its use commencing in 1997. Four wells (North Waihee and Kanoa wells) have been developed to spread the pumpage over the Waihee and Iao Aquifers, supplementing and extending the water supply for the Central Maui System. The DWS is continuing well development efforts in this area with Kupaa Well 1, Maluhia Well, and Waiolai Well.

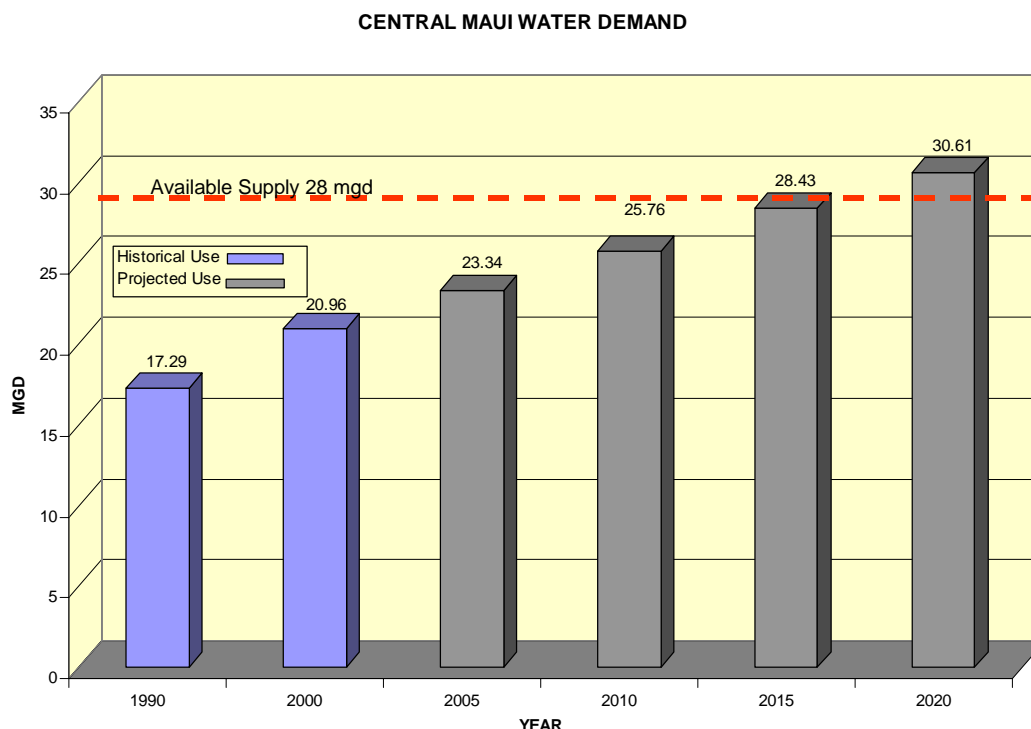
The average daily water demand for the Central Maui System for year ending June 2001 was 20.96 mgd. By comparison, the comparable demand in 1990-91 period was 17.29 mgd, an increase of 21 percent. In the Wailuku-Kahului Community Plan region, the municipal demand was 8.7 mgd, an increase of 7 percent from the 1991 level of 8.13 mgd. By the year 2020, total water demand is projected to increase by 53 percent of present consumption to 13.33 mgd. In the Kihei-Makena Community Plan region, the municipal demand was 11.82 mgd, an increase of 33 percent from the 1991 level of 8.86 mgd. By the year 2020, total water demand is projected to increase by 40 percent to 16.57 mgd.

The Kihei-Wailea district has absorbed most of the growth in this region, with a 36 percent increase in water demand from 1991. Single and multi-family residential developments are the primary users of water, followed by hotel and commercial uses.

The Iao Aquifer provides most of the water supply for the Central Maui system with a water source withdrawal rate of approximately 17 mgd. Additional sources are being sought in the Waihee, Paia, and Haiku aquifers, as well as the use of surface water originating on the northwest side.

The sustainable yield for the Iao Aquifer is estimated at 20 mgd by the State Commission on Water Resource Management (CWRM). In November 2002, the CWRM established a limit on pumpage from Iao of 18 mgd (90 percent of the sustainable yield). Pumpages in 2001 from wells tapping the basal aquifer averaged 17.4 mgd, or 87 percent of the sustainable yield. The development of wells in the Waihee Aquifer, which lies just beyond the Iao Aquifer to the north has greatly helped sustain growth in the Central Maui system.

The bar chart below shows the combined demand projections for the Community Plan regions in the Central Maui system, including Wailuku-Kahului, Kihei-Makena, and Paia, which comprise the DWS system. Available supply capacity is estimated at 28 mgd, based on 90 percent of sustainable yield in Iao (18 mgd) and Waihee (7 mgd) Aquifers, and Iao Tunnel and surface water (3 mgd), but excluding future East Maui sources.



The planned direction for future source development is towards East Maui beyond Paia, where there are undeveloped groundwater sources and moderately high estimates of sustainable yield. The CWRM-estimated sustainable yield for the Paia and Haiku aquifers are 8 mgd and 31 mgd, respectively.

The East Maui Water Development Plan (1992) was prepared to meet the needs of the Central Maui Water System. The plan proposes the development of well fields in the Paia-Haiku area to provide an average of 10 mgd.

In order to avoid CWRM designation of Iao Aquifer as a Water Management Area, the DWS is keeping withdrawal pumpage to under 90% of sustainable yield. The Waihee Aquifer Development Plan is ongoing, as well as efforts to develop water on the border of the Waikapu Aquifer to distribute the withdrawal from Iao. The use of the Waihee-Iao ditch surface water as well as conservation, ground water protection and watershed protection will also be pursued.

The timetable to provide the first water from East Maui is not until after 2005 due to pending litigation. The implementation of the East Maui Plan consists of six phases over 15 years with the development of 10 new wells. The installation of the transmission mains will begin at the well field and proceed in a westerly direction until they connect with the existing Central Maui Transmission main.

C. West Maui Community Plan Region

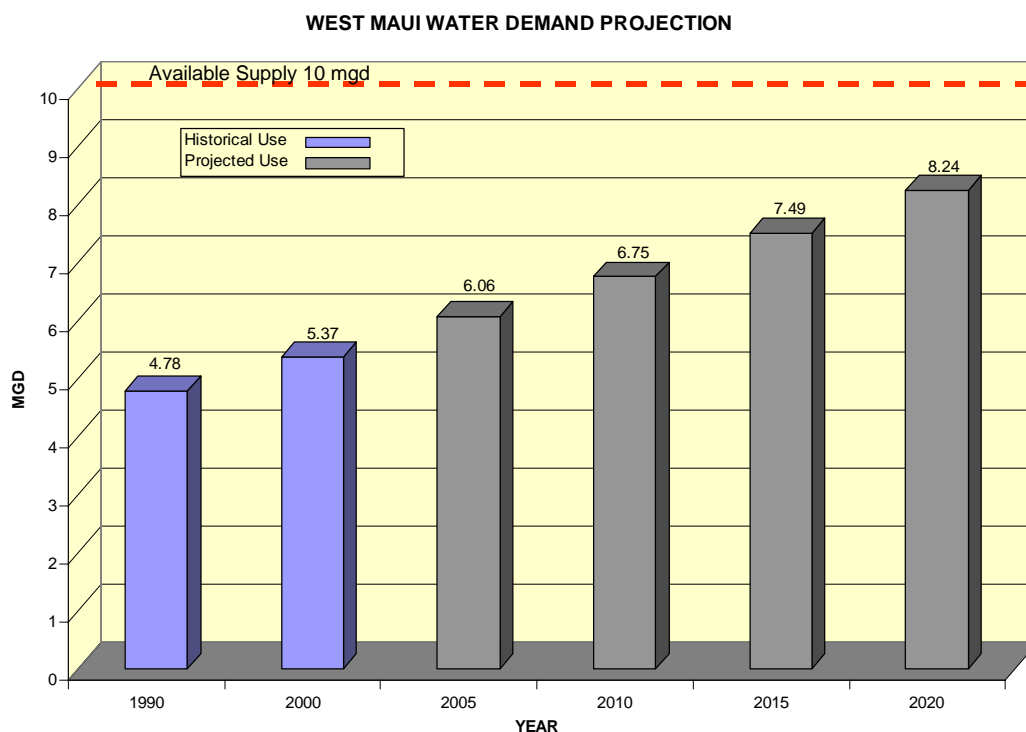
The municipal Lahaina Water System serves most of the resident population with potable water. The system serves the coastal areas from Launiupoko to Kaanapali, and from Honokowai to Napili. The resort areas of Kaanapali and Kapalua are fully served by private systems. The major private systems include Kaanapali (Amfac/JMB) and Kapalua (Maui Land and Pineapple Co. Ltd).

The Lahaina System water sources consist of 2 surface sources and 9 wells. The Kanaha intake taps surface water from the Kanaha Stream, and the Alaeloa and Honokohau intakes withdraw surface water from Maui Pineapple Company's Honokohau Tunnel.

There are two plants in Lahaina providing treatment to surface water sources. The Lahaina Water Treatment Plant treats surface water from Kanaha Stream and has an average production of 1.6 mgd. The Mahinahina Water Treatment Plant near the Kapalua Airport draws surface water from the Honokohau, Honolua, and Kanaha Streams. Average treatment production is 2.4 mgd.

In the West Maui Community Plan region, the municipal demand was 5.37 mgd for the year ending June 2001, including the communities of Lahaina, Honokowai, Alaeloa and Honokohau. This represents an increase of 12 percent from 1991. The Kapalua Water System provides 0.5 mgd of domestic water use, while the Kaanapali System provides 2.8 mgd of domestic water use. By the year 2020, total water demand is projected to increase by 53 percent to 8.24 mgd.

The bar chart below shows projected water demands for the DWS system in West Maui. Available supply of 10 mgd is based on assumed developable yields of 3 mgd in the Honokohau Aquifer, 4 mgd in Honolua Aquifer, and 3 mgd of additional surface water treatment capability.



The Lahaina Water System relies on surface water sources from the Honokohau Tunnel and Kanaha Stream as well as ground-water wells. A major constraint is that the surface water must be treated to increasingly stringent standards of the Safe Drinking Water Act administered by the Environmental Protection Agency (EPA). Water treatment plants have been developed and upgraded to bring surface water up to the EPA's standards. There is some potential for expanding surface water sources, provided there is adequate treatment capacity. The two County water treatment facilities at Mahinahina and Lahaina have a maximum combined capacity of approximately 6 mgd.

In the Honolua aquifer mauka of Napili, the County has five wells and there is some surplus sustainable yield. The Honokohau aquifer inland of Honokohau Bay holds some potential for future ground water supply, as an estimated 2-3 mgd may be safely developed from basal wells. The remote location of this aquifer, however, translates to high storage and transmission costs.

For the area served by the County DWS, total water demand is projected to increase from 5.37 mgd in 2001 to 8.24 mgd by the year 2020, an overall increase of 2.87 mgd or approximately 53 percent of present consumption over the planning period. The greatest needs are for single-family residential use and for hotel use.

For the County in the long-term, ground-water development may still provide additional sources to meet future demands. The Honokohau aquifer system has an estimated 10 mgd of sustainable yield with no existing ground water withdrawals. Due to its remote location inland of Honokohau Bay, however, extensive transmission systems and additional storage facilities would be needed. In the Honolua aquifer system mauka of Honokahua Bay, there

is approximately 4 mgd surplus sustainable yield which could be developed. With potential yields of 0.8 mgd each, additional wells could be developed in Honokahua and Honolulu. For the projected water demands, the development of additional wells may be pursued in upper Mahinahina and upper Napili which would yield 0.72 mgd each.

D. Makawao-Pukalani-Kula Community Plan Region

The Makawao-Pukalani-Kula region is supplied primarily by surface water sources. The municipal systems include the Makawao and the Kula systems, which also service the upper portions of the Paia- Haiku community plan region.

The major source for the Makawao system is the intake at the end of the Wailoa Ditch system at approximately the 1,100 foot elevation. The Kamole Water Treatment Plant with a capacity of 8 mgd is located at this site.

The Kula system consists of an upper and lower system. The upper system is along the 4,200 feet elevation collecting surface water from Haipuaena, Puohakamoa, and Waiakamoi Streams. The water treatment plant at Olinda has a capacity of 1.7 mgd. Major storage reservoirs include the 30 MG Waikamoi reservoirs and the 100 MG Kahakapao reservoir.

The lower system serves the Omaopio, Olinda, and Lower Kula communities. The system consists of over 13 miles of water lines, 7 pump stations, and the 50 MG Piiholo Reservoir. The system begins at the 3,000-foot elevation and diverts water from the Haipuaena, Puohakamoa, Waiakamoi and Honomanu Streams.

During dry periods, the Kula system is supplemented by water pumped from the Makawao system. With the development of the Kahakapao reservoir, the need for pumping has been significantly reduced.

In 1999-2000, four ground-water sources were made available to service the Upcountry water system during drought conditions. These sources include the Haiku well, Hamakuapoko Wells 1 and 2, and Kaupakalua well, which can deliver up to 3.5 mgd, or about 40 percent of the average demand during drought conditions. The Hamakuapoko Wells are under a court order restriction limiting service during drought conditions only.

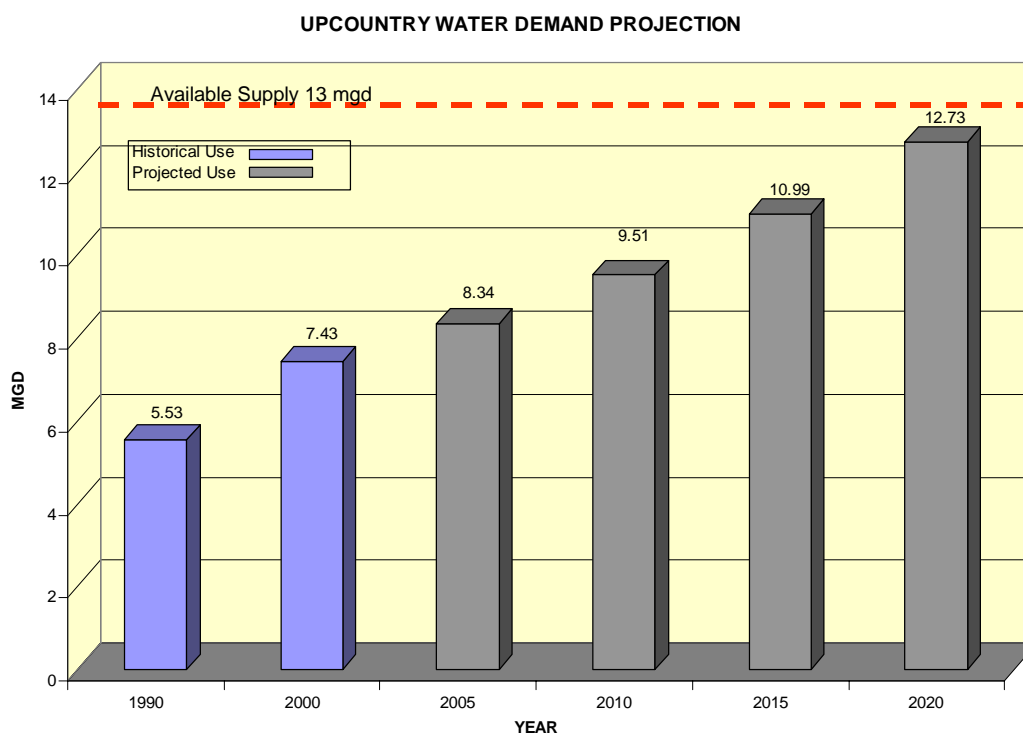
In the Makawao-Pukalani-Kula Community Plan region, the municipal demand was 6.41 mgd in the year ending June 2001, including the communities of Makawao, Pukalani, Haliimaile, Kula, and Ulupalakua. This is an increase of 33 percent over 1991 consumption of 4.83 mgd.

The Upcountry area has long been faced with problems of inadequate supply during prolonged dry periods. Most of the service area is at too high an elevation to be economically supplied by water pumped from lower elevations where ground and surface water sources are more easily developed. Streamflow at the higher elevations are highly variable and subject to extremes in the hydrologic cycles. Extensive storage capacity in reservoirs much greater than presently exists are needed to stabilize water supply, but these are costly to develop.

With the development of the Hamakuapoko, Kaupakalua, and Haiku wells, the Upcountry water systems can now be served with these ground-water sources. The DWS is also pursuing the development of additional source with Pookela Well and additional storage with the Kula Raw Water Reservoir.

Water demand for the Community Plan region is projected to increase from 6.4 mgd in 2001 to 11.05 mgd by the year 2020, an overall increase of 4.65 mgd or approximately 72 percent of present consumption over the planning period. Total water demand for the Upcountry DWS system that includes Haiku is projected to increase from 7.44 mgd in 2000 to 12.73 mgd by 2020. The greatest needs are for single-family residential use and for agriculture.

The bar chart below shows the Upcountry water demands, including the Makawao-Kula Community Plan region and the Haiku area. The available supply capacity of 13 mgd is a tentative estimate assuming 8 mgd of surface water treatment based on current production rates and 5 mgd from groundwater sources including the proposed Pookela Well. The surface water sources are dependent on ditch and stream flows, and some of the groundwater sources are used only to supplement surface supplies during dry periods.



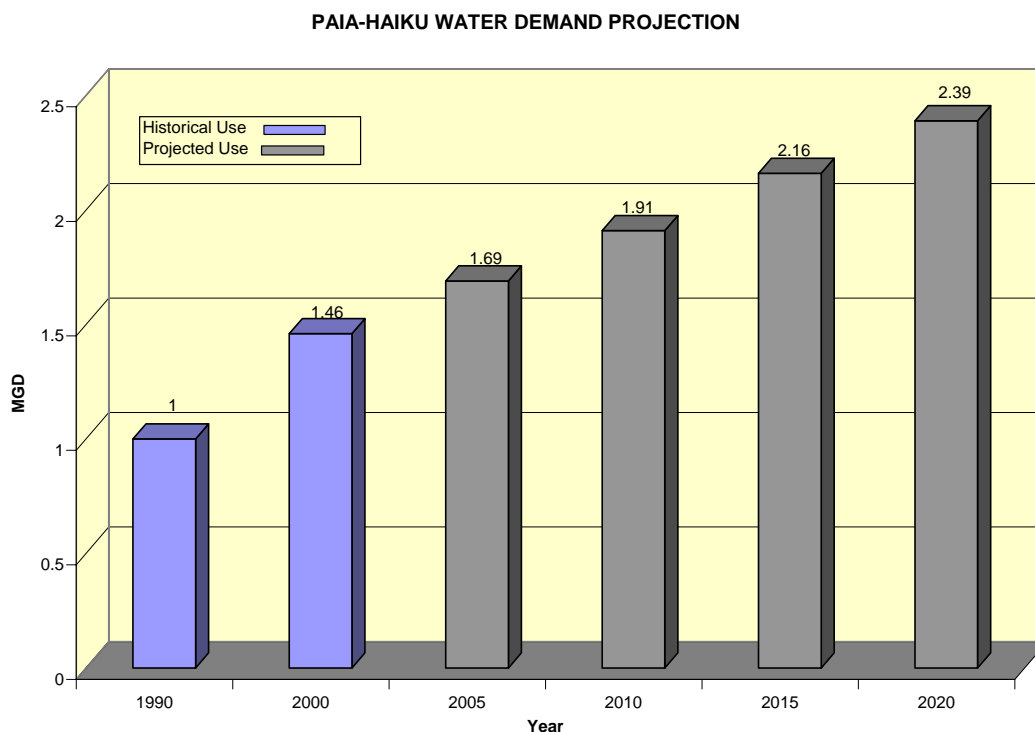
The Pookela Well development will help improve reliability of supply. A portion of the water supply from the Hamakuapoko and proposed Haiku wells may also be pumped to the Makawao system. It is also anticipated that the dual water system being implemented by the Soil Conservation Service and currently in its early phases of implementation will relieve some demand on potable supplies while reducing non-potable costs by eliminating the need to treat water to be used for irrigation.

E. Paia-Haiku Community Plan Region

The Paia-Haiku Community Plan Region includes the Paia Aquifer System and the Haiku Aquifer system. In the Paia-Haiku Community Plan region, the demand was 1.39 mgd in the year ending June 2001. This is an increase of 36 percent over 1.02 mgd consumption in 1991.

The Paia-Haiku region is part of the DWS Central Maui and Upcountry system and as such shares similar system constraints and opportunities. The ten wells proposed for use and development as part of the East Maui Water Development Plan are within the Paia and Haiku Aquifers.

Total water demand for the region is projected to increase from 1.46 mgd in 2001 to 2.39 mgd by the year 2020, an overall increase of 0.93 mgd or approximately 63 percent of present consumption over the planning period. The greatest needs are for single-family residential use.



F. Hana Community Plan Region

The Hana Community Plan Region includes the serviced area between Kaeleku Agricultural Park and Hamoa Town where water supply is provided by the Maui County Department of Water Supply, Hana Water Resources, and Hana Water Company.

The County Department of Water Supply system consists of three deep wells (Wakiu A and B and Hamoa Well), 500,000-, 190,000-, and 40,000-gallon storage tanks in Hamoa and

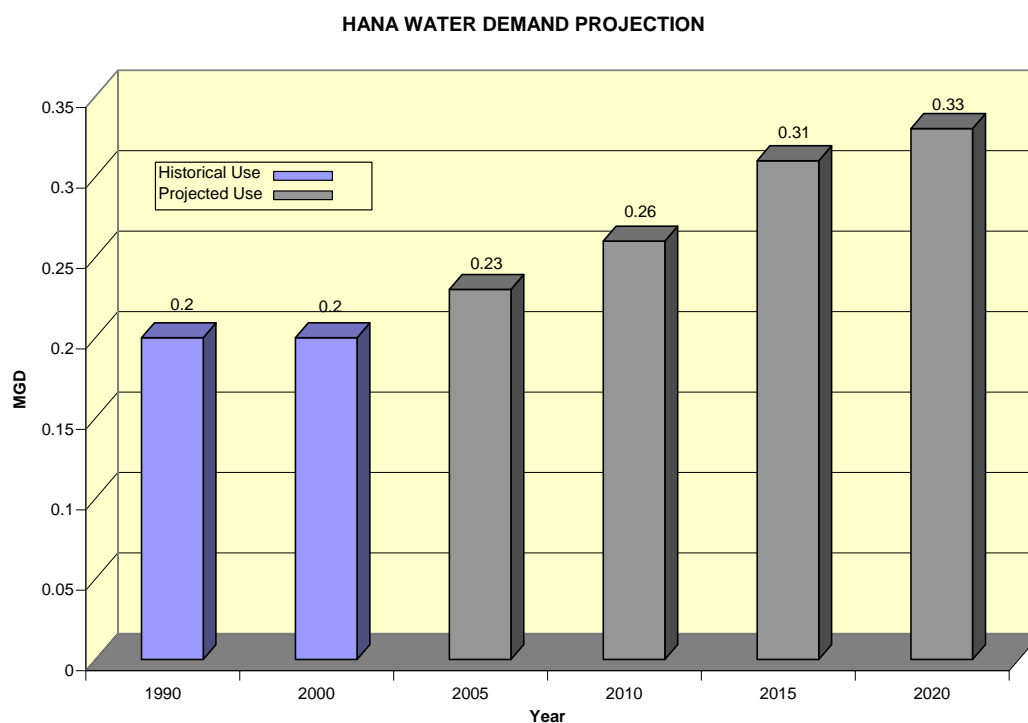
Hana, and a surface water source located on Wailua Stream. One of the deep wells, however, Wakiu Well A, has been out of service since 1997 and the surface water source of Wailua Stream is presently not used.

In the Hana Community Plan region, the DWS demand was 0.20 mgd in the year ending June 2001. This amounts to a 0.5 percent increase over the 0.19 mgd consumption in 1991.

The major need for the Hana system is provide redundancy/back up at both ends of the system between Wakiu and Hamoa. DWS is adding a well at Hamoa, and improving transmission between the Hamoa and Wakiu wells.

Total water demand for the region is projected to increase from 0.20 mgd in 2001 to 0.33 mgd by the year 2020, an overall increase of 0.13 mgd or approximately 65 percent of present consumption over the planning period. Given the relatively low levels of water use in the area, there are no supply constraints in terms of source capacity.

The need for backup and redundancy for all areas of the system are being addressed by improved transmission between Wakiu and Hamoa, and the addition of another well at Hamoa.



G. Molokai Community Plan Region

The Molokai Community Plan Region encompasses the entire island of Molokai. Water district sub-areas under the Department of Water Supply include Kawela-Kaunakakai, Ualapue, Kalae, and Halawa on the east side of the island. The Department of Hawaiian Home Lands system services the homestead lots, while the Molokai Irrigation System and the Department of Agriculture systems in central Molokai serve agricultural interests. Kaluakoi, Molokai Ranch, and Alpha, Inc., each of whom have independent water systems, privately own the west side of Molokai.

Nearly all of Molokai's water comes from wells dug to tap the basal reservoirs. The west and central sections of the island, which require the most water, have aquifer systems that produce relatively low amounts of potable water. Some of the surface water resources have been utilized, mostly the 2.7 mgd that the Molokai Irrigation System diverts from the northeast sector.

In the Molokai Community Plan region, the DWS demand was 0.93 mgd in the year ending June 2001. This is an increase of 58 percent over 0.59 mgd consumption in 1991.

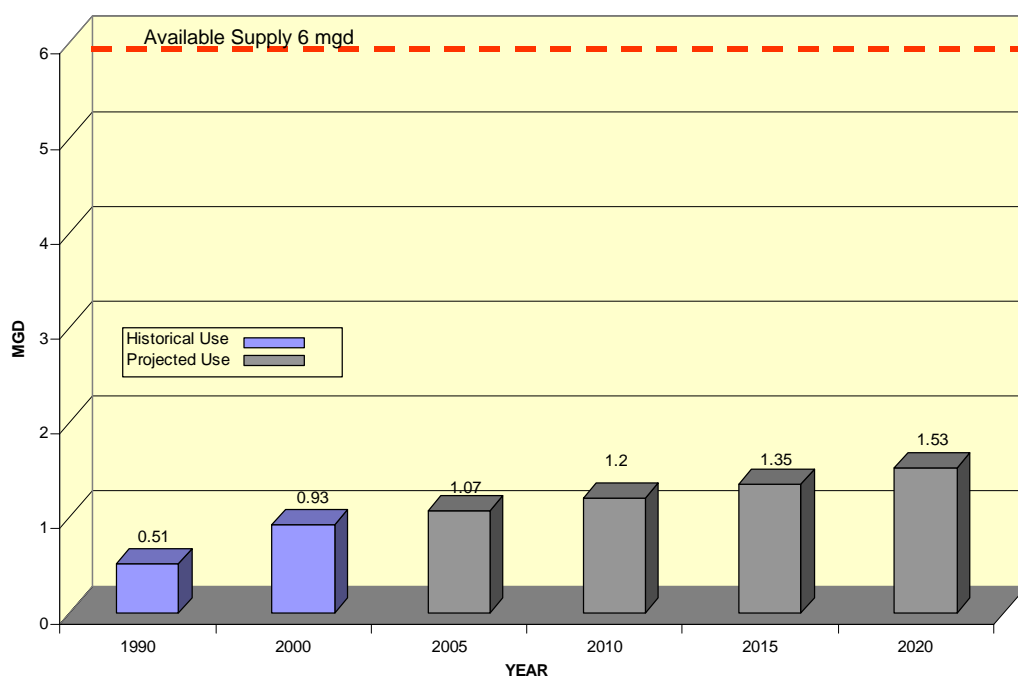
In July 1992, the island of Molokai was designated as a Water Management Area by the State Commission on Water Resource Management (CWRM). This designation meant that all existing uses needed to be permitted, and any proposed uses or withdrawals from water sources would require the approval of the CWRM.

In October 1992, the Molokai Working Group was convened by the CWRM to recommend a plan for water development on Molokai that assists the County and Molokai community in developing its Water Use and Development Plan. The Final Report of the Molokai Working Group (1996) cites that agriculture will continue to be the economic and cultural "heart" of Molokai, but that the capacity of the aquifers should be treated conservatively and protected until more precise determinations can be made.

For the DWS component of Molokai's supply, total water demand is projected to increase from 0.93 mgd in 2001 to 1.53 mgd by the year 2020, an overall increase of 0.6 mgd or approximately 64 percent of present consumption over the planning period. The greatest need is for single-family residential use. The DWS serves the Kaunakakai-Kawela-Ualapue area of Molokai.

The bar chart below shows the projected water demands for the DWS system on Molokai. Available supply of 6 mgd is a tentative estimate based on assumed developable yields and restrictions from the Molokai Working Group Plan for Kualapuu (1 mgd), Kamiloloa (1 mgd), Kawela (1.5 mgd), and Ualapue (2.5 mgd) Aquifers.

MOLOKAI WATER DEMAND PROJECTION



The Final Report of the Molokai Working Group Plan addressed future water needs. The four remaining “tough” issues to be resolved include: 1) ground-water and wellhead protection for Molokai; 2) Hawaiian and DHHL rights to water; 3) streamflow protection and possible restoration; and 4) Kualapuu wellfield protection.

The DWS’s near term plans include a backup well for the Kaunakakai-Kawela system in the Kawela aquifer (1 mgd capacity well). The existing Kawela well has inadequate capacity to backup the system should the Kualapuu well malfunction. If emergency service is needed, backup could be provided by the DHHL and Molokai Irrigation System. However, the additional DWS well would provide the needed backup for reliability and to distribute some pumpage from the more heavily used Kualapuu aquifer.

H. Lanai Community Plan Region

The Lanai Community Plan Region encompasses the entire island of Lanai. The primary sources consist of six (6) wells tapping the aquifers in the mountainous central sector of the island. These wells pumped a total of 1.84 mgd in 2001 to service Lanai City, Koele and Manele Resort areas, and Kaunapau. The distribution of this water included 0.65 mgd to Lanai City and the Koele Hotel, 1.17 mgd to the Manele Resort area, diversified agriculture and Airport, and 0.01 mgd to Kaunapau. There are no County DWS water systems on Lanai.

Although Lanai has been determined to have a 6.0 mgd sustainable yield by the CWRM, a management guideline limit of 4.3 mgd was established, which would be reconsidered when water usage reached that level.

The Lanai Water Working Group was initially formed and prepared the Final Report of the Lanai Working Group in February 1997. Since 1997, the Working Group has been reconvened under the auspices of DWS as the Lanai Water Advisory Committee.

The 1995 consumption determined from billing records was 1.57 mgd. With a limited supply of water to support existing and future development, protection of the island's water resources is a principal concern of the water use plan.

The Lanai Water Advisory Committee is working on final agreement for the amount of use that would trigger the required development of new sources. The State's numerical model indicated that 6 mgd sustainable yield was available, but since the distribution of withdrawals was not optimal, the full sustainable yield amount cannot be withdrawn without damage to the aquifer. The group is considering a water use trigger of 3.5 mgd at which point new source development will be required, or when operational guideline triggers have been reached, whichever occurs first.

Sustainable yield is also dependent upon the Lanaihale watershed remaining intact in its current state or better. The Lanai Water Advisory Committee will continue to monitor progress on forest protection, and to serve as a member of the Lanai Forest and Watershed Partnership which it co-founded to ensure that the watershed is protected.

I. INTRODUCTION

This section presents an assessment of the existing water systems within the County of Maui, including Molokai and Lanai, and the Community Plan regions of Wailuku-Kahului, Kihei-Makena, West Maui, Makawao-Pukalani-Kula, Paia-Haiku, and Hana. The focus of this study is on the County's domestic water system and supply, and more specifically on the potable water supply which is the primary need for accommodating future growth and development in the County and respective community plan regions.

The objective of this assessment is to identify the domestic water supply-related constraints and opportunities within the County of Maui and determine appropriate time frames for improvements based on the projected demand and the capacities of the present water systems.

The findings herein are not meant to represent a master plan for water systems development. The Maui Department of Water Supply is undertaking a comprehensive update of its Water Use and Development Plan through the Integrated Resource Planning process. The intent of this assessment is to focus on the growth-related constraints and improvements which should be considered in the course of updating the County's General Plan and Community Plans.

II. ASSESSMENT METHODOLOGY

In the County of Maui, the Maui Department of Water Supply (DWS) is responsible for the development, operation and maintenance of the municipal water system and supply. In November 2002, a charter amendment was approved to restructure the DWS as a regular county agency subject to the major's executive management oversight (the DWS was previously a semi-autonomous agency). There are five major water systems on Maui Island which comprise the municipal service areas, several of which overlap community plan boundaries.

Table 1
MUNICIPAL WATER SYSTEMS

COMMUNITY PLAN REGION	WATER SYSTEM
Wailuku-Kahului	Central Maui
Kihei-Makena	Central Maui
Paia-Haiku	Central Maui and Makawao
West Maui	Lahaina
Makawao-Pukalani-Kula	Makawao and Kula
Hana	Hana
Molokai	Molokai
Lanai	Lanai Water Company (private)

Wailuku-Kahului and Kihei-Makena community plan regions are wholly contained within the Central Maui System, the principal system supplying the most densely developed and populated areas of Maui. The Central Maui System also includes the Lower Paia Town area which lies in the Paia-Haiku community plan region.

The Lahaina System is within the West Maui community plan region, but the municipal system serves along with major private systems, including Kaanapali and Kapalua.

The Makawao and the Kula System encompass the Makawao-Pukalani-Kula community plan region. The Haiku area is also served by the Makawao System.

The Hana and Molokai systems are wholly contained within the respective DWS Hana and Molokai water system districts. Lanai is a private system operated by the Lanai Water Company.

Due to the boundary differences between the water districts and the community plan regions, analyses of supply and demand required sub-area district breakdowns of water use and demand in order to apply water systems data to the community plan regions.

A. Demand and Forecast Methodology

Water use in the County DWS system areas was tabulated by land use categories and sub-districts from data compiled by Haiku Design and Analysis for the DWS through billings and metered consumption. The land use categories include Single-Family, Multi-Family, Commercial, Hotel, Industrial, Government, Agriculture, and Religious uses. Consumption varied widely among the sub-areas, and average daily demand for each of the major land use classes was estimated for each community plan region. Unit consumption data was used to derive projected increases in demand. Per unit consumption was derived by dividing total water use in a category by the number of metered services.

The projected demand for water is based on projections supplied by the Socio-Economic Forecast Study Update (SMS, May 2002). The projections include population growth, households, employment, and visitor projections to the year 2020 for each island and community plan region. The “Baseline Projection” was used, which is based on the State Department of Business, Economic Development and Tourism’s long term forecast model and incorporates year 2000 Census data.

Residential demand was based on households, apportioned to single and multi-family uses by community plan area based on land use allocations in the prior Land Use Forecast Study (Wilson Okamoto and Associates, 1992). Residential densities were based on planned project district developments, with the projected mix of single and multi-family units in each region derived from project district developments and census housing unit data. Commercial-industrial demand was based on projected employment growth in these categories. Hotel demand was based on visitor unit projections. Stable demand was assumed for religious and agricultural uses in the absence of projections for these uses. Tables showing the calculations for projected increases in demand are appended to this report.

The Department of Water Supply is developing several water demand forecasts in conjunction with the Maui County Water Use and Development Plan (WUDP). The WUDP forecasts may differ substantially from the water demand projections in the Infrastructure Assessment Update (Update). The differences are a result of differences in purpose, assumptions and methods used.

The Infrastructure Assessment Update water demand projections indicate future water demand based on the SMS Socio-Economic Forecast baseline demographic projections. The water demand projections assume that future water consumption for single family and multi family customers will grow directly in proportion to growth in households predicted in the SMS forecast. Growth in commercial, industrial and hotel water consumption is assumed to grow in direct proportion with the predicted growth in employment.

The Department of Water Supply WUDP projections differ in several respects. The forecasts are prepared for geographical areas other than the Community Planning Districts, including forecasts by water system, water district, and geographical area. Several forecast methods are used including trending and econometric forecasts.

The econometric forecasts are based on SMS Socio-Economic Forecast but with alternated assumptions regarding the allocation of future growth to each Community Plan District. A range of forecast assumptions is incorporated to generate base, high, low, medium high and medium low scenarios.

The econometric forecast method allows many additional factors to be taken into account in projecting future water demands. The forecasts are derived based on data corrected for the effects of rainfall on water consumption in each water district and geographical area. The econometric forecasts are based on multi-variate regression analyses that consider many demographic and economic projections that affect water demand, including resident population, defacto population, average visitor census, housing data, employment and jobs by industry, per capital income, temperature, precipitation, and water price.

III. CENTRAL MAUI COMMUNITY PLAN REGIONS

A. Existing System/Service

The Wailuku-Kahului and Kihei-Makena Community Plan regions are part of the Central Maui Water System (See Figure 1), which services the communities of Waihee and Waiehu to the north, Wailuku, Kahului, Paia to the east, and Maalaea-Kihei-Makena to the south. Within the Wailuku-Kahului Community Plan region, water district sub-areas include Wailuku, Waihee, Waikapu, Wailuku Heights, Kahului, Puunene, and Spreckelsville. Within the Kihei-Makena Community Plan region, water district sub-areas include Kihei, Maui Meadows, Wailea, Makena, and Maalaea.

The Central Maui System water sources are located on the windward slope of the West Maui Mountains. Approximately 75 percent of the water to supply the Central Maui System is withdrawn from the Iao Aquifer in the vicinity of Iao Stream and Waiehu Stream. The balance of 25 percent is withdrawn from the adjacent Waihee Aquifer to the northwest. The base perennial flows in Iao and Waiehu valleys originate as ground-water seepage from high level aquifers in the caldera and dike complex of the West Maui Mountains. The ground-water resource occurs in the basal lens extending between Waikapu and Waihee valleys below the 800-foot elevation.

The Waihee Aquifer was tapped with the North Waihee well development, with its use commencing in 1997. Four wells (North Waihee and Kanoa wells) have been developed to spread the pumpage over the Waihee and Iao Aquifers, supplementing and extending the water supply for the Central Maui System. The DWS is continuing well development efforts in this area with Kupaa Well 1, Maluhia Well, and Waiolai Well.

The sources from the Iao and Waihee Aquifers are shown in Table 2. The Iao Tunnel is a high level source which does not tap the basal aquifer. A surface source is also available for use – water can be drawn from the Iao-Waihee Ditch and filtered at the Iao Treatment Plant.

Table 2
CENTRAL MAUI SYSTEM SOURCES

CENTRAL MAUI SYSTEM	7-00 TO 6-01 1,000 GALS	MGD
Mokuhau 501	811,610	2.22
Mokuhau 502	-	-
Mokuhau 503	992,754	2.72
Waihee 577	862,794	2.36
Waihee 578	803,445	2.20
Waihee 579	106,050	0.29
Waiehu Hts 514	249,114	0.68
Waiehu Hts 515	320,826	0.88
Wailuku Shaft	1,874,045	5.13
Kepaniwai 511	312,397	0.86

Iao Aquifer Subtotal		17.35
North Waihee #1	517,471	1.42
North Waihee #2	466,182	1.28
Kanoa #1	419,841	1.15
Kanoa #2	46,199	0.13
Iao Tunnel	434,658	1.19
Iao-Waihee Ditch and Iao Treatment Plant	0	0
Central Maui Total		22.51

Beyond the distribution network in Wailuku-Kahului, two major transmission pipelines deliver water to Kihei-Makena and one pipeline carries water past Kahului Airport to Paia.

B. Existing Demand

The average daily water demand for the Central Maui System for year ending June 2001 was 20.96 mgd. By comparison, the comparable demand in 1990-91 period was 17.29 mgd, an increase of 21 percent.

1. Wailuku-Kahului

In the Wailuku-Kahului Community Plan region, the municipal demand was 8.70 mgd, an increase of 7 percent from the 1991 level of 8.13 mgd. This area includes the DWS sub-districts of Wailuku, Waihee, Waikapu, Wailuku Heights, Kahului, Spreckelsville, and Puunene. Table 3 shows a breakdown of demand by water sub-district.

Table 3
WAILUKU-KAHULUI WATER DEMAND (mgd)

WAILUKU-KAHULUI SUB-DISTRICTS	1991	2001	% CHANGE
111 Wailuku	3.02	3.50	16%
113 Waihee	0.12	0.09	-28%
115 Waikapu	0.11	0.16	44%
117 Wailuku Heights	0.2	0.23	17%
131 Kahului	4.32	4.41	2%
141 Puunene	0.19	0.11	-44%
173 Spreckelsville	0.16	0.24	48%
Total	8.13	8.70	7%

As may be expected, the urban centers comprising the Wailuku and Kahului sub-districts show the greatest demand, with 3.50 mgd and 4.41 mgd respectively in the fiscal year 2001. Compared with the 1991 demands, most of the districts experienced an increase in demand; Wailuku showed a 16 percent increase, Kahului had a 2 percent increase. With water use closely tied to land use, most of the water demand is from single-family residential developments, although Wailuku and Kahului have significant demands from commercial, industrial and governmental uses.

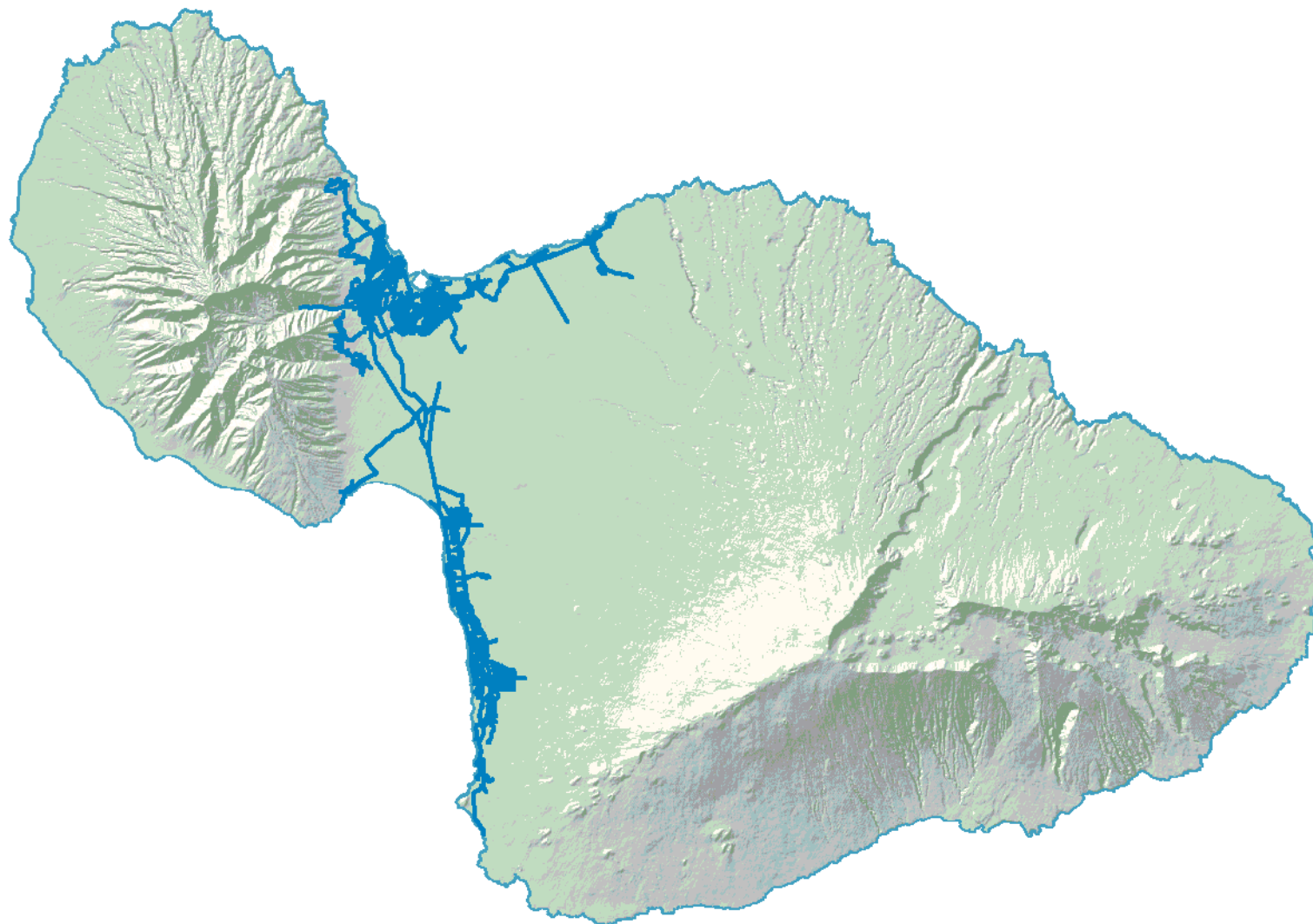
FIGURE 1

CENTRAL MAUI
WATER SYSTEM
WAILUKU – KAHULUI
PAIA – HAIKU
KIHEI - MAKENA

Source:
County of Maui
Department of
Water Supply



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ENGINEERS - PLANNERS



2. Kihei-Makena

In the Kihei-Makena Community Plan region, the municipal demand was 11.82 mgd, an increase of 33 percent from the 1991 level of 8.86 mgd. This area includes the DWS sub-districts of Kihei, Maalaea, Makena and Wailea (formerly part of Kihei Sub-District).

Table 4 shows a breakdown of demand by sub-district.

Table 4
KIHEI-MAKENA WATER DEMANDS (mgd)

KIHEI-MAKENA SUB-DISTRICTS		1991	2001	% CHANGE
151	Kihei	8.21	8.90	8%
153	Maalaea	0.24	0.26	7%
155	Makena	0.4	0.50	26%
157	Wailea		2.27	
		8.86	11.82	33%

The Kihei-Wailea district has absorbed most of the growth in this region, with a 33 percent increase in water demand from 1991. Single and multi-family residential developments are the primary users of water, followed by hotel and commercial uses.

C. Existing System Constraints and Opportunities

The Iao and Waihee Aquifer Systems are two of four aquifer systems in the Wailuku Aquifer Sector of Maui (see Figure 2, Island of Maui Hydrologic Units). The Iao and Waihee Aquifers are adjacent systems with basal water level differences, but are considered to be hydraulically connected.

The sustainable yield for the Iao Aquifer is estimated at 20 mgd by the State Commission on Water Resource Management (CWRM). Concern over pumpages in amounts nearing the aquifer's sustainable yield has prompted a request by a community group for the State to designate the Iao Aquifer as a Water Management Area to regulate withdrawals. In November 2002, the CWRM established a limitation on pumping from Iao of 18 mgd (90 percent of sustainable yield). Pumpages in 2001 from wells tapping the basal aquifer averaged 17.4 mgd, or 87 percent of the sustainable yield. Sustainable yield is defined as the maximum continuous rate of pumping from an aquifer that will not impair the utility of the water or the rate at which it is withdrawn. This yield represents the estimated maximum amount of ground water that can be withdrawn without harming the aquifer's ability to replenish itself. Sustainable yields should be considered as estimates, which need to be confirmed through long term ground-water monitoring.

The development of wells in the Waihee Aquifer, which lies just beyond the Iao Aquifer to the north has greatly helped sustain growth in the Central Maui system. However, sustainable yield in the Waihee Aquifer is 8 mgd, and current pumpage of 4 to 5 mgd already approaches the recommended limits of withdrawals.

FIGURE 2

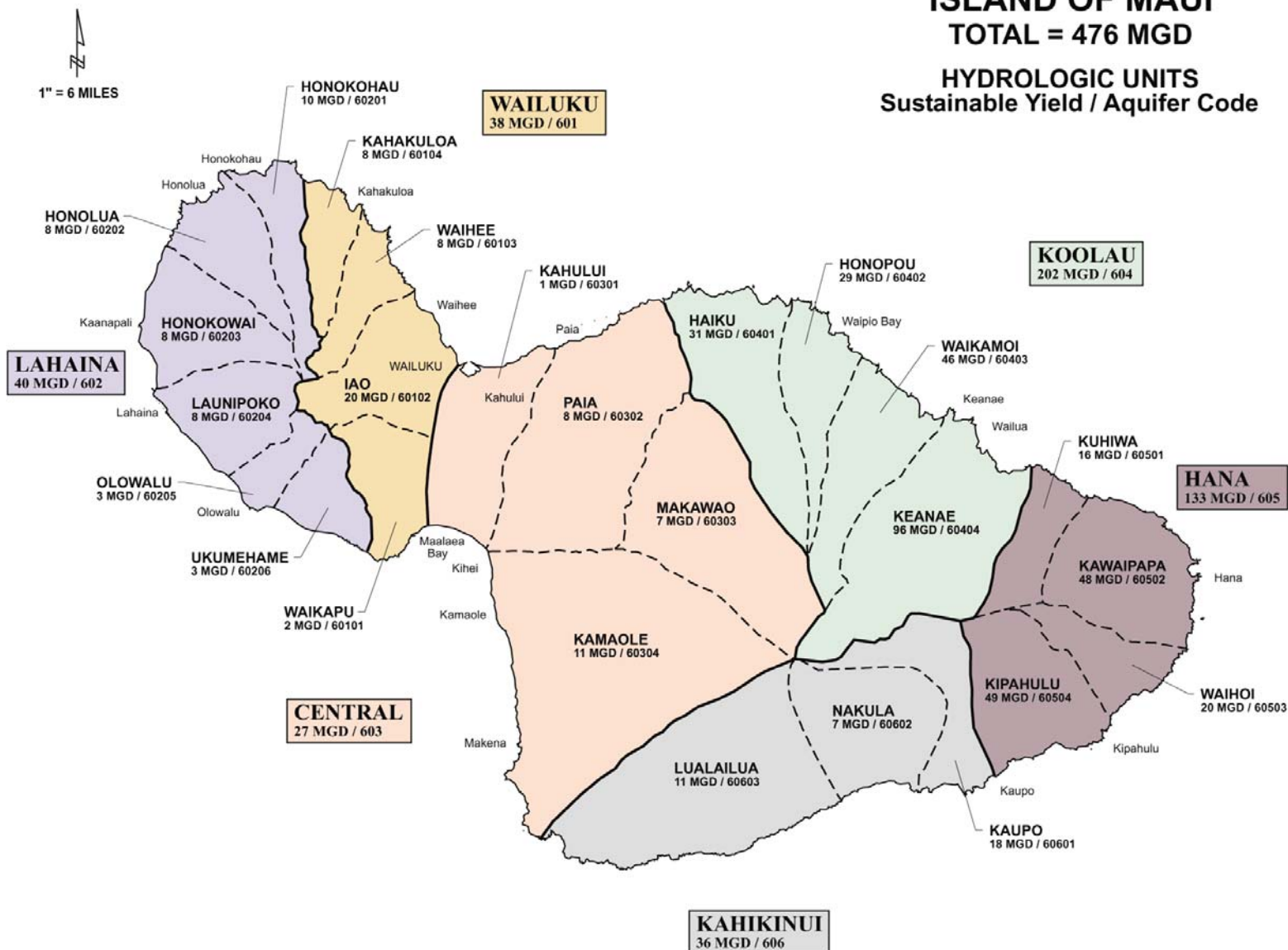
ISLAND OF MAUI
HYDROLOGIC UNITS

Source:
State of Hawaii
Commission on
Water Resource
Management



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& ASSOCIATES, INC.
ENGINEERS - PLANNERS

ISLAND OF MAUI
TOTAL = 476 MGD
HYDROLOGIC UNITS
Sustainable Yield / Aquifer Code



The planned direction for future source development is towards East Maui beyond Paia, where there are undeveloped groundwater sources and moderately high estimates of sustainable yield. The CWRM-estimated sustainable yield for the Paia and Haiku aquifers are 8 mgd and 31 mgd, respectively. Updated sustainable yield estimates for the Haiku region in 1999 range from 14.7 to 26.9 mgd (Final SEIS for the East Maui Water Development Plan, 2002, p. 31). The major constraint is the distance of these sources from the Central Maui service area, which requires the installation of extensive storage and transmission facilities.

The East Maui Water Development Plan (1992) was prepared to meet the needs of the Central Maui Water System. The plan proposes the development of well fields in the Paia-Haiku area to provide an average of 10 mgd. The Hamakuapoko wells would eventually be connected by means of transmission lines extending 23,000 feet to the Central Maui transmission system. Development and use of this source are discussed in the section on proposed improvements.

In order to protect the Iao Aquifer, the DWS is pursuing the following actions:

- Projects to better distribute the withdrawals within the aquifer
- Projects to relocate withdrawals outside of the aquifer (development of source outside the aquifer)
- Purchase of lands for watershed management and protection
- Funding of watershed management and protection efforts
- Groundwater protection
- Conservation – DWS has distributed more than 20,000 low flow fixtures, with retrofit programs under consideration. There is also ongoing flow and pressure monitoring and leak detection for suspected problem areas.

D. Future System Service Requirements

1. Projected Demand

The projected demand for water in the Wailuku-Kahului region is based on projections supplied by the County of Maui Socio-Economic Forecast Study Update (SMS, May 2002). The projections include population growth projections to the year 2020 as well as household, employment, and visitor unit growth for each island and community plan region. Tables showing the projected unit and acreage increases are appended to this report. Existing average consumption patterns in the various land use categories are used in the projections.

Table 5 with a line graph (See Chart 1) shows the water demand projections by land use categories for the target years 2005, 2010, 2015, and 2020. Years 1990 and 2001 water use is provided for comparison and reference. Total water demand is projected to increase from 8.70 mgd in 2001 to 13.33 mgd by the year 2020, an overall increase of 4.63 mgd or approximately 53 percent of present consumption over the planning period.

Table 5
Wailuku-Kahului Water Demand Projections

7/12/02

WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	1990		2000		2005	Added	Total	2010	Added	Total	2015	Added	Total	2020	Added	Total
	Use	Ave.	Use	Ave.	Increase	Use	Use	Increase	Use	Use	Increase	Use	Use	Increase	Use	Use
	(Mgd)	Use*	(Mgd)	Use*		(Mgd)	(Mgd)		(Mgd)	(Mgd)		(Mgd)	(Mgd)		(Mgd)	(Mgd)
Wailuku-Kahului	3.44	469	4.24	477	1402	0.67	4.90	2722	1.30	5.53	4046	1.93	6.17	5387	2.57	6.81
Single-Family	0.57	337	0.81	337	350	0.12	0.93	681	0.23	1.04	1011	0.34	1.15	1347	0.45	1.26
Multi-Family	2.71	3126	1.92	3126	86	0.27	2.19	194	0.61	2.53	311	0.97	2.89	430	1.34	3.27
Comm./Industrial	0.09	206	0.05	206	28	0.01	0.06	55	0.01	0.06	104	0.02	0.07	154	0.03	0.08
Hotel	0.12	-	0.15	-	0.00	0.00	0.15	0.00	0.00	0.15	0.00	0.00	0.15	0.00	0.00	0.15
Agriculture	1.20	-	1.54	-	-	0.14	1.67	-	0.28	1.81	-	0.42	1.96	-	0.56	1.76
Govt./Religion	8.13		8.70			1.21	9.90		2.43	11.12		3.68	12.39		4.95	13.33

*Unit = gpd/unit

Chart 1
Wailuku-Kahului Water Demand Projection

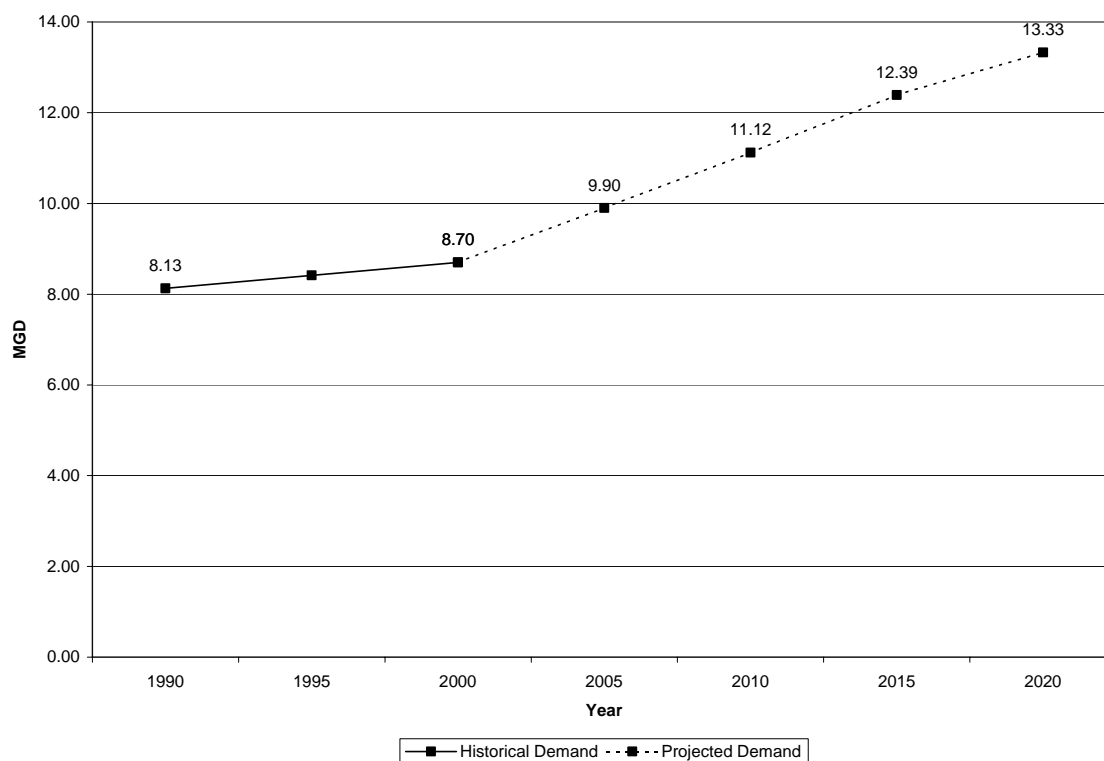


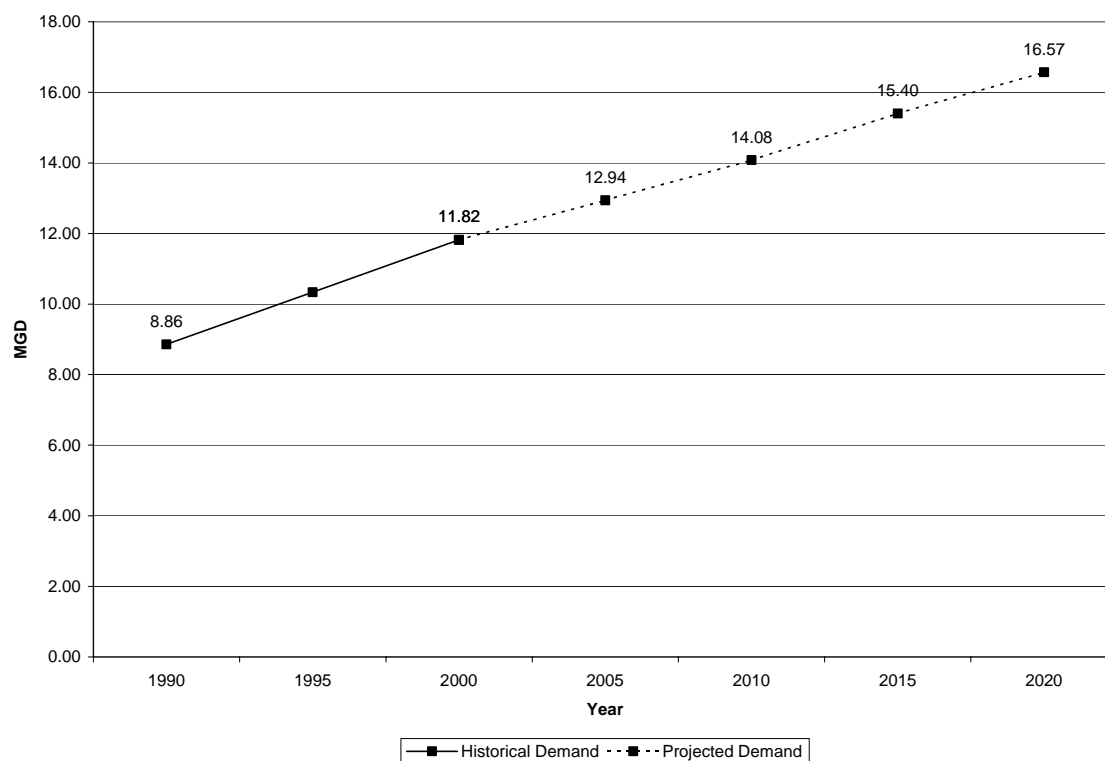
Table 6
Kihei-Makena Water Demand Projections

7/12/02
WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	1990 Use (Mgd)	Ave. Use* (Mgd)	2000 Use (Mgd)	Ave. Use* (Mgd)	2005 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2010 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2015 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2020 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)
Kihei-Makena	2.99	983	3.87	947	559	0.53	4.40	1086	1.03	4.90	1614	1.53	5.40	2000	1.89	5.77
Single-Family	2.51	380	3.75	380	457	0.17	3.92	888	0.34	4.09	1320	0.50	4.25	1636	0.62	4.37
Multi-Family	1.80	7563	1.05	7563	21	0.16	1.21	50	0.38	1.43	80	0.61	1.65	111	0.84	1.89
Comm./Industrial	1.00	537	2.09	537	420	0.23	2.31	811	0.44	2.52	1540	0.83	2.91	2275	1.22	3.31
Hotel	0.29	-	0.61	-	0.00	0.00	0.61	0.00	0.00	0.61	0.00	0.00	0.61	0.00	0.00	0.61
Agriculture	0.27	-	0.45	-	-	0.04	0.49	-	0.09	0.53	-	0.13	0.58	-	0.17	0.62
Govt./Religion	8.86		11.82			1.13	12.94		2.28	14.08		3.60	15.40		4.74	16.57

*Unit = gpd/unit

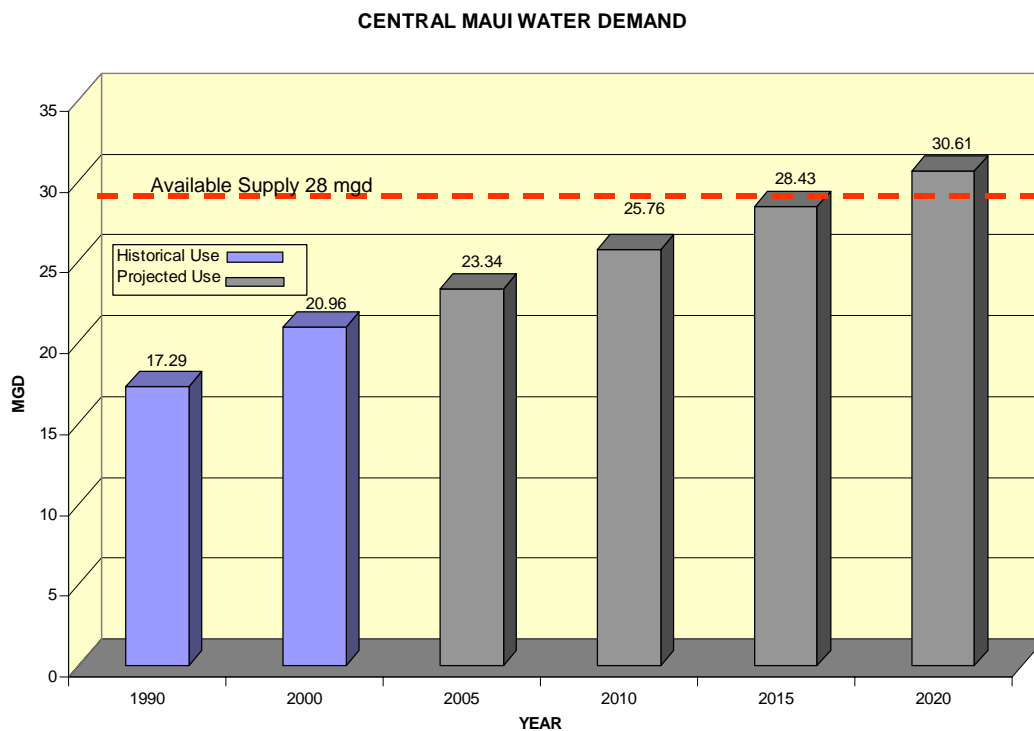
Chart 2
Kihei-Makena Water Demand Projection



The greatest needs are for single-family residential use and for commercial and industrial use.

For the Kihei-Makena region, Table 6 with a line graph (See Chart 2) shows the water demand projections by land use categories for the target years 2005, 2010, 2015, and 2020. Years 1990 and 2001 water use are provided for comparison and reference. Total water demand is projected to increase from 11.82 mgd in 2001 to 16.57 mgd by the year 2020, an overall increase of 4.75 mgd or approximately 40 percent of present consumption over the planning period. The greatest needs are for single-family residential use and for hotel use.

The bar chart below shows the combined demand projections for the Community Plan regions in the Central Maui system, including Wailuku-Kahului, Kihei-Makena, and lower Paia Town area, which comprise the DWS system. The baseline projections indicate the need for approximately 30.6 mgd by 2020 for the Central Maui System. Available supply capacity is estimated at 28 mgd, based on 90 percent of sustainable yield in Iao (18 mgd) and Waihee (7 mgd) Aquifers, and Iao Tunnel (1 mgd) and Iao surface water (2 mgd), but excluding future East Maui sources.



2. Future System Requirements and Costs

Iao Aquifer currently supplies 75 percent (17 mgd) of the water used in the Central Maui Water System. Adjacent aquifers and non-basal ground water supply 5 mgd. In keeping with the CWRM limits for pumping from the Iao Aquifer, the DWS is keeping withdrawal pumpage to less than 18 mgd. In December 2002, the Iao Stream surface water treatment

plant was placed into operation to augment potable water supplies. The plant can treat up to 2 mgd depending on ditch flow.

The Waihee Aquifer Development Plan is ongoing (Kupaa, Maluhia, and Waiolai Wells), as well as efforts to develop water on the border of the Waikapu Aquifer to distribute the withdrawal from Iao (Waikapu Well). The planned use of the Waihee-Iao ditch surface water, with the development of a surface water treatment plant, could yield 2 mgd.

The DWS also proposes to undertake a comprehensive monitoring and modeling study for the Central Maui system, including the status of the Iao and Waihee aquifer systems, and ground-water recharge and flow modeling to simulate existing conditions, determine the effects of withdrawal scenarios, and investigate additional sources of ground water in Central Maui.

The Supplemental EIS for the East Maui Water Development Plan has been finalized, but still faces litigation. As such, the provision of water from East Maui is not expected until after 2005. The implementation of the East Maui Plan consists of six phases with the development of 10 new wells. Development of one well per year in these areas will cost approximately \$2 million and add about 0.5 to 0.75 mgd per average day to the water system. Two of the wells are in the Paia Aquifer System and have already been drilled. The remaining eight wells will be in the Haiku Aquifer System. Average yield of the completed project is 10 mgd, which is two-thirds of the installed capacity based on DWS standards.

New transmission pipe lines are also needed. The installation of the transmission lines will begin at the well field and proceed in a westerly direction until they connect with the existing Central Maui Transmission main. The six phases are expected to be completed in 15 years. Total cost estimate is \$48.5 million in 2004 dollars.

The implementation phases proposed are as follows:

Phase 1: Two new wells in the Hamakuapoko region of the Paia Aquifer System; 1.4 mgd yield total; total installed capacity of 2 mgd. A transmission main would connect the well field to the Upper Paia water tank. The Hamakuapoko wells are completed but are pumped only during drought emergencies. The water is treated to remove DBCP. Construction of the transmission line to Paia has not been started.

Initially, modifications are proposed to the existing system at Paia and Spreckelsville to supply these areas as well as portions of Kahului with the 2.0 mgd wells being developed. A new pipeline would be developed parallel to Kailua Gulch from Sunnyside Road to Hana Highway. The existing waterline would serve as a transmission line.

Phase 2: Two new wells in the Haiku area of the Haiku Aquifer System; 2.0 mgd yield total; installed capacity of 3 mgd. The transmission line would be extended to Kahului Airport. A 2.0 MG storage tank on Baldwin Avenue would be developed at the 560-foot elevation. In the east direction, the transmission line would be extended to the new wells.

Phase 3: Two new wells in the Haiku Aquifer System; 2.0 mgd yield total; installed capacity of 3 mgd; The transmission main would be extended to Puunene.

Phase 4: Two new wells in the Haiku Aquifer System; 2.7 mgd yield total; total installed capacity of 4 mgd.

Phase 5: Extend the transmission main to the Central Maui Transmission Main.

Phase 6: Add two new wells in the Haiku Aquifer System; 1.4 mgd yield total; installed capacity of 4 mgd.

Table 7 summarizes the proposed project costs and increase in supply by the target planning periods. The table includes the estimated costs for the Central Maui water system of developing the source, transmission, and storage facilities for the East Maui ground water development.

Table 7
CENTRAL MAUI WATER SYSTEM PROPOSED IMPROVEMENTS

PROJECT	COST
<u>Projects to meet 2005 demand</u>	
Iao Source Development - Waikapu Well	\$ 350,000
North Waihee Source Development – Maluhia Wells	\$ 2,450,000
N. Waihee Source Dev. – Transmission, Kupaa Well Site to System	\$ 800,000
N. Waihee Source Dev.– Kupaa Wells	\$ 2,625,000
N. Waihee Source Dev.– Transmission, Maluhia Well Site to System	\$ 500,000
N. Waihee Source Dev. - Waiolai Exploratory/Well Development	\$ 2,400,000
N. Waihee Source Dev. - Transmission, Waiolai Well Site to System	\$ 1,500,000
Total	\$10,625,000
<u>Projects to meet 2010 demand</u>	
Iao Source Development - Iao Tank Site	\$ 1,900,000
Kihei Storage Tank	\$ 2,500,000
Kihei Waiakoa Storage Tank (1 mg)	\$ 1,950,000
Waihee Ditch System and Treatment Plant (2 mgd)	\$ 5,300,000
East Maui Source Development – Kauhikoa Wells (two wells - 1.5 mgd each)	\$ 2,600,000
East Maui Source Development – West Kuiaha Wells (two wells - 1.5 mgd each)	\$ 2,000,000
East Maui Source Development - Transmission from Phase IIa from Kauhikoa Wells to Hamakuapoko Wells	\$ 5,470,000
East Maui Source Development - Transmission from Phase IIb Sunny Side Road and 4 MG tank	\$ 1,800,000
East Maui Source Development - Transmission from Phase IIIa from West Kuiaha Wells to Kauhikoa Wells	\$ 2,600,000
East Maui Source Development - Transmission from Phase IIIb from Hana Highway to Spanish Road	\$ 4,401,000
Treatment for Kauhikoa Wells	\$ 6,060,000
Treatment for West Kuiaha Wells	\$ 6,060,000
Total	\$37,341,000
<u>Projects to meet 2015 demand</u>	
Kahului Storage Tank	\$ 2,500,000
East Maui Source Development – East Kuiaha Wells (two wells – 2 mgd each)	\$ 3,205,000
East Maui Source Development - Transmission from Phase IV from East Kuiaha to West Kuiaha Wells	\$ 1,115,000
Treatment for East Kuiaha Wells	\$ 6,060,000
Upcountry Pipe Line Link	\$ 3,000,000
Total	\$15,880,000
<u>Projects to meet 2020 demand</u>	
East Maui Source Development – Peahi Wells (two wells – 2 mgd each)	\$ 5,342,000
East Maui Source Development - Transmission from Phase V from Spanish Road to Kuihelani Highway	\$ 4,737,000
Treatment for Peahi Wells	\$ 6,060,000
East Maui Source Development – Ulumalu Wells (two wells – 2mgd each)	\$ 3,535,000
East Maui Source Development - Transmission from Phase VI from Peahi Wells to Kuiaha Wells	\$ 662,000
Total	\$20,336,000

IV. WEST MAUI COMMUNITY PLAN REGION

A. Existing System/Service

The West Maui Community Plan region is characterized by the two major resort areas of Kaanapali and Kapalua, by historic Lahaina Town with surrounding residential and commercial development, and by pineapple cultivation and former sugar cane lands in the mauka areas.

The municipal Lahaina Water System (See Figure 3) serves most of the resident population with potable water. The system serves the coastal areas from Launiupoko to Kaanapali, and from Honokowai to Napili. The resort areas of Kaanapali and Kapalua are fully served by private systems. The major private systems include Kaanapali (Amfac/JMB) and Kapalua (Maui Land and Pineapple Co. Ltd).

The Lahaina System water sources consist of 2 surface sources and 9 wells. The Kanaha intake taps surface water from the Kanaha Stream, and the Alaeloa and Honokohau intakes withdraw surface water from Maui Pineapple Company's Honokohau Tunnel. The Honokohau Tunnel is comprised of about 12 miles of tunnels, ditches, and siphons from an intake at Honokohau Stream to upper Lahaina Town. The tunnel begins in Honokohau Valley at the 870 foot level and ends at Mahinahina at the 720 foot elevation, where the tunnel transitions into a ditch. Maui Pineapple Company diverts water from the tunnel for irrigation, while Kapalua also uses the source for its private domestic water supply. The ditch system has an average flow of 25 mgd.

The sources for the Lahaina Water System are shown in Table 8.

Table 8
LAHAINA DWS SOURCES

LAHAINA SOURCES	2000-2001 1,000 GALS	MGD
Lahaina WTF	610,097	1.67
Mahinahina WTF	842,912	2.31
Kanaha 575	42,649	0.12
Kanaha 576	22,261	0.06
Waipuka 559	30,575	0.08
Waipuka 560	52,588	0.14
Napili A	-	-
Napili B	180,342	0.49
Napili C	273,249	0.75
Honokahua A 572	-	-
Honokahua B 573	127,343	0.35
Total		5.98

From Alaeloa to the north side of Lahainaluna Road in Lahaina Town, water is obtained from Honokohau Tunnel and the high elevation Napili basal wells. Reservoirs in Alaeloa,

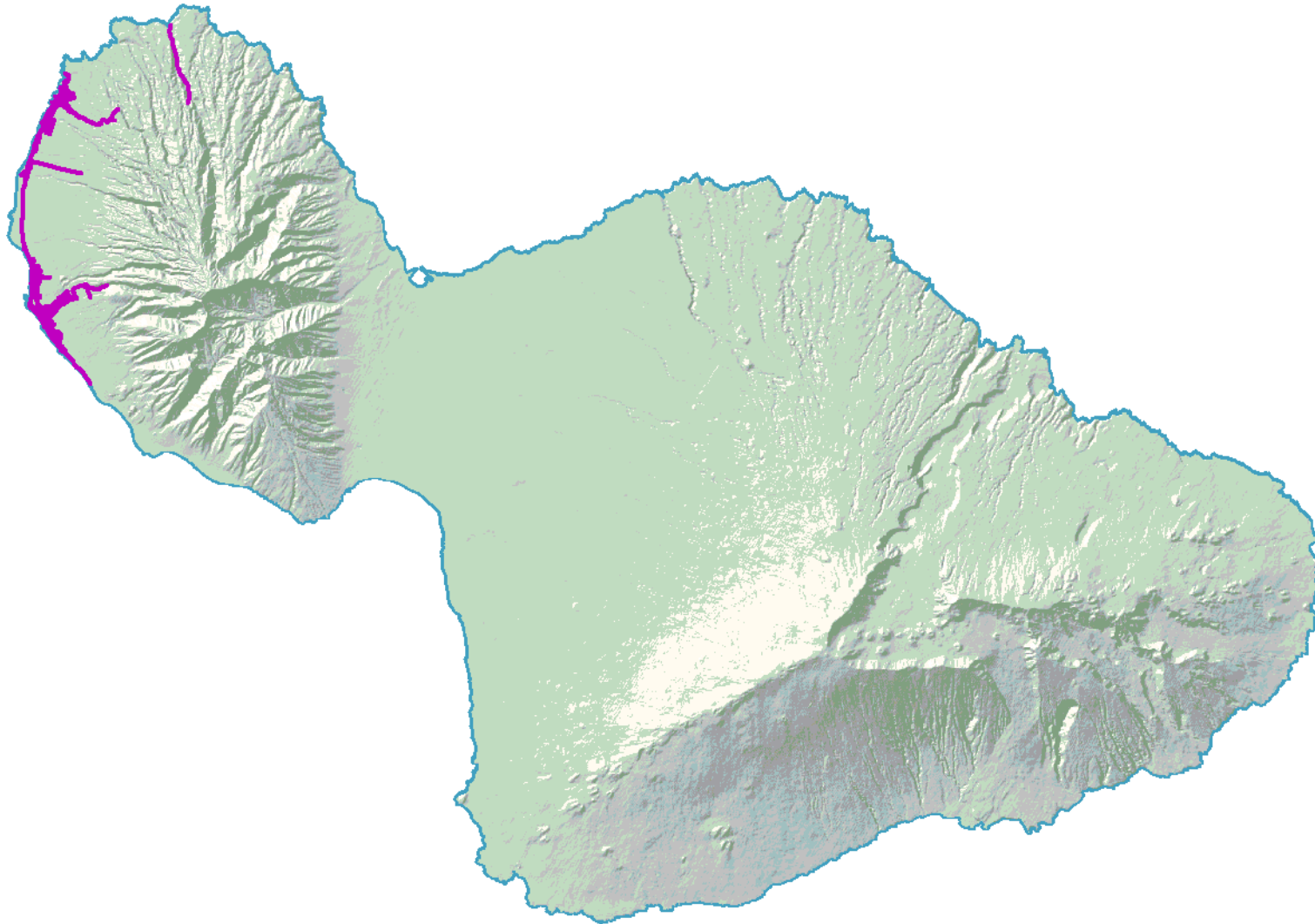
FIGURE 3

WEST MAUI
WATER SYSTEM

Source:
County of Maui
Department of
Water Supply



WILSON OKAMOTO
& ASSOCIATES, INC.
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Honokowai, and Wahikuli have storage capacities of 1.0 MG, 2.0 MG and 1.5 MG respectively, and are connected by approximately 36,000 lineal feet of 16-inch main along Honoapiilani Highway.

In the Lahaina Town area east of Honoapiilani Highway and south of Lahainaluna Road, water is from surface water in Kanaha Valley and four basal wells. Kanaha surface water is shared by the County and the Lahainaluna School. County water is transmitted to the 0.3 MG Kanaha Reservoir, then to reservoirs along Lahainaluna Road with capacities of 0.5 MG and 1.0 MG.

There are two plants in Lahaina providing treatment to surface water sources. The Lahaina Water Treatment Plant, constructed in 1997, uses a microfiltration process to treat surface water. The facility's source of water is Kanaha Stream and has an average production of 1.6 mgd. The Mahinahina Water Treatment Plant near the Kapalua Airport draws surface water from the Honokohau, Honolua, and Kanaha Streams. Average treatment production is 2.4 mgd.

The County is also working to supply an area within Honokohau Valley with a line from one of Kapalua's wells to service approximately 15 connections with a small average consumption of less than 5,000 gpd.

The Kapalua Water System (Private) serves the entire Kapalua Resort development and golf courses. Irrigation uses non-potable surface water drawn from the Honokohau Tunnel. Kapalua Water Company has 3 wells, 2 of which are in operation, with a capacity of 1 mgd. Domestic consumption served by the potable wells averages approximately 0.5 mgd.

The Kaanapali Water System (Private) serves the Kaanapali Resort area. The Kaanapali Water Corporation, which previously owned and operated the private system, was acquired by Aqua Source in 1999. The service area includes hotels, clubhouse, commercial facilities and residential subdivisions extending from Puukolii Road south to the Maui Hyatt Regency Hotel and about one-mile inland. Irrigation requirements for the golf courses and agricultural fields are met by separate systems using the R-1 effluent from the County's Lahaina Wastewater Reclamation Facility and separate golf course water sources. Potable water is supplied by basal groundwater obtained from 7 wells at high elevations above Honokowai and Mahinahina. Water is stored in three 1.5 MG reservoirs. With backup and service contingencies, the system can supply up to 4.90 mgd. Due to elevated levels of Dibromochloropropane (DBCP) in several of the wells, a water treatment facility is being constructed near these wells.

B. Existing Demand

In the West Maui Community Plan region, the municipal demand was 5.37 mgd for the year ending June 2001, including the communities of Lahaina, Honokowai, Alaeloa and Honokohau. This represents an increase of 12 percent from 1991. Table 9 shows the breakdown of water demand by sub-district. The municipal demand represents metered consumption, and is less than the quantity withdrawn (see previous section) due to leakages or otherwise unaccounted-for water.

Table 9
WEST MAUI WATER DEMANDS (mgd)

LAHAINA SUB-DISTRICTS		1991	2001	% CHANGE
511	Lahaina	2.49	2.77	11%
513	Honokowai	1.73	1.77	2%
515	Alaeloa	0.56	0.83	48%
517	Honokohau	0.00	0.00	
	Total	4.78	5.37	12%

The Kapalua Water System provides 0.5 mgd of domestic water use, while the Kaanapali System provides 2.8 mgd of domestic water use.

C. Existing System Constraints and Opportunities

The Lahaina Water System relies on surface water sources from the Honokohau Tunnel and Kanaha Stream as well as ground-water wells. A major constraint is that the surface water must be treated to increasingly stringent standards of the Safe Drinking Water Act administered by the Environmental Protection Agency (EPA). Water treatment plants have been developed and upgraded to bring surface water up to the EPA's standards. The DWS has developed a 1.5 MG water treatment plant in Lahaina mauka of Lahainaluna School and a 2.5 MG water treatment plant in Mahinahina, mauka of Honoapiilani Highway.

There is some potential for expanding surface water sources, provided there is adequate treatment capacity. The Honokohau Tunnel system is a reliable source. Average withdrawal rate for major users include 5.5 mgd for Maui Pineapple, 4.5 mgd for Kapalua Land Co., 2.0 mgd for Kapalua Water Co., and 4 to 4.5 mgd for the County DWS. The residual ditch flow reaching the irrigation reservoir at the end of the system is between 11 and 12 mgd. Prior to closing, Pioneer Mill used the residual flow for sugar cane irrigation. The two County water treatment facilities at Mahinahina and Lahaina have a maximum combined capacity of approximately 6 mgd.

Another constraint of the Lahaina system is the long transmission distance between the Alaeloa end of the system and the Lahaina end. The system could be better integrated and made more efficient if the DWS were to acquire the private water systems, or if an authority such as a committee of purveyors were established to coordinate improvements and provide back-up facilities for emergencies, service and maintenance.

With the cessation of sugar cane cultivation, there has been a significant reduction in return irrigation which would decrease sustainable yields. In the late 1980s, Pioneer Mill pumped about 20 mgd from the basal aquifers. With subsequent reductions in acreage, this pumpage was reduced to less than 10 mgd. However, the ground-water hydrology in the Lahaina area between Honokowai and Launiupoko is directly affected by the irrigation return flow of sugar cane which was cultivated over 5,000 acres. As such, the net effects of closure of the plantation on available water yields is uncertain at this time.

The basal lens mauka of the developed areas are thin because they are not confined at the coast by caprock. Ground-water development must occur more than two miles inland with wells drilled at high elevations.

In the Honolua aquifer mauka of Napili, the County has five wells and there is some surplus sustainable yield. Kapalua has an additional existing well available to meet their future demands.

The Honokohau aquifer inland of Honokohau Bay holds some potential for future ground water supply, as an estimated 2-3 mgd may be safely developed from basal wells. The remote location of this aquifer, however, translates to high storage and transmission costs.

D. Future System Service Requirements

1. Projected Demand

The projected demand for water in the West Maui region is based on projections supplied by the County of Maui Socio-Economic Forecast Study Update (SMS, May 2002). The projections include population growth projections to the year 2020 as well as household, employment, and visitor unit growth for each island and community plan region. Tables showing the projected unit and acreage increases are appended to this report. Existing average consumption patterns in the various land use categories are used in the projections.

Table 10 with a line graph (See Chart 3) shows the water demand projections by land use categories for the target years 2005, 2010, 2015, and 2020. Years 1990 and 2001 water use are provided for comparison and reference. Total water demand is projected to increase from 5.37 mgd in 2001 to 8.24 mgd by the year 2020, an overall increase of 2.87 mgd or approximately 53 percent of present consumption over the planning period. The greatest needs are for single-family residential use and for hotel use.

Because the West Maui region includes major private water suppliers (Kaanapali, Kapalua, Launiupoko/Olowalu land holdings group and Kamehameha Schools), the DWS versus private proportion of land uses in the region was prorated based on land use data in the 1992 Infrastructure Assessment as follows: single-family residential (85% DWS), multi-family residential (61%), commercial/industrial (73%), hotel (22%), and government/religion (100%). The proportionate water use was applied in calculating DWS projected water needs.

No assumptions are made relative to the State Housing and Community Development Corporation of Hawaii's (HCDCH) Lahaina master-planned community in Wahikuli which is in litigation over ceded lands. HCDCH has previously proposed to develop its own wells and dedicate them to the County, in which case the County would not need to fund source development, transmission and storage for the additional demand generated by the large scale housing development.

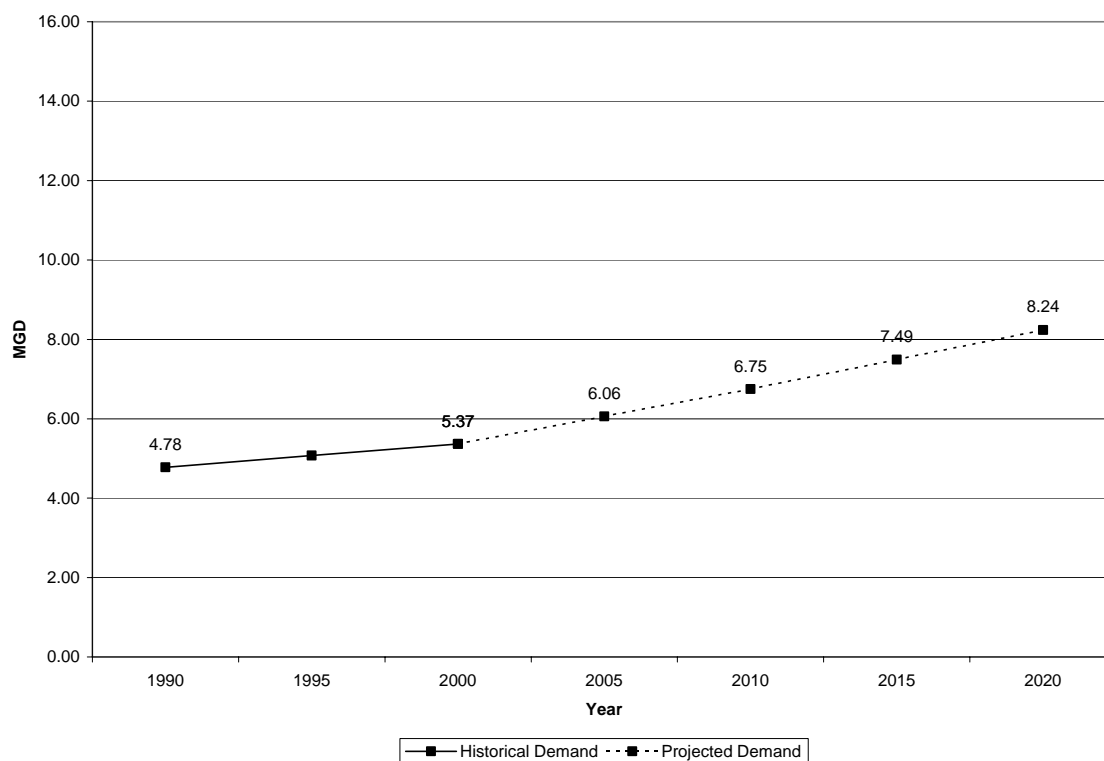
Table 10
West Maui Water Demand Projections

7/12/02
WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

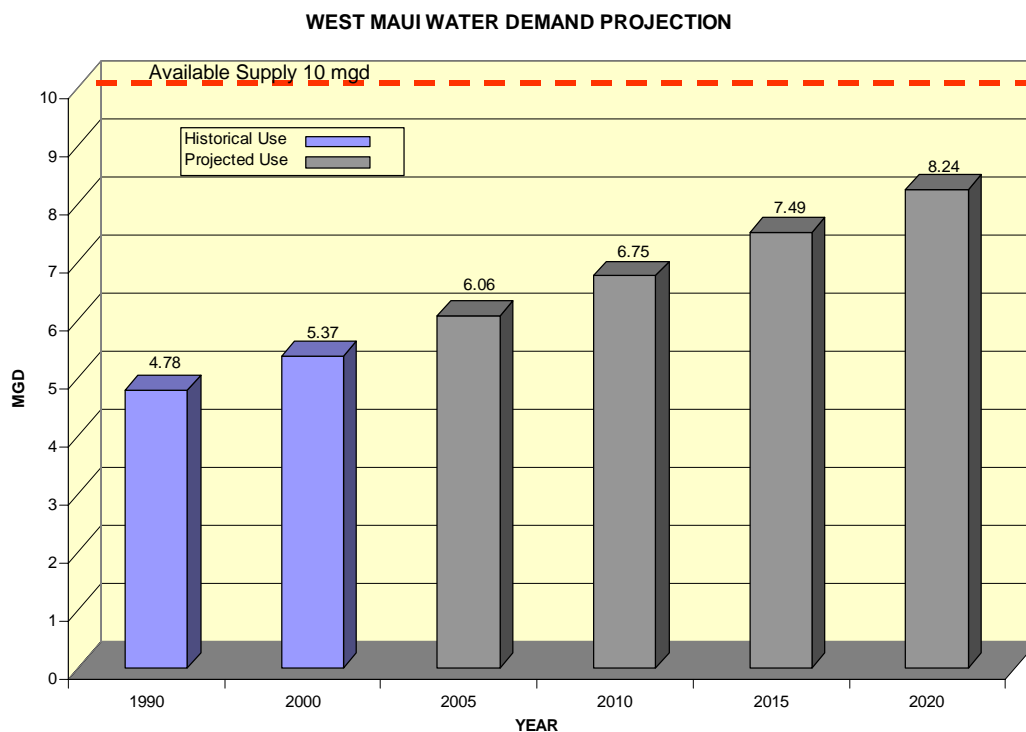
	1990		2000		2005	Added	Total	2010	Added	Total	2015	Added	Total	2020	Added	Total
	Use	Ave.	Use	Ave.	Increase	Use	Use	Increase	Use	Use	Increase	Use	Use	Increase	Use	Use
	(Mgd)	Use*	(Mgd)	Use*		(Mgd)	(Mgd)		(Mgd)	(Mgd)		(Mgd)	(Mgd)		(Mgd)	(Mgd)
West Maui																
Single-Family	1.45	650	1.65	701	562	0.39	2.05	1091	0.77	2.42	1622	1.14	2.79	2160	1.51	3.17
Multi-Family	1.35	428	1.74	428	101	0.04	1.78	196	0.08	1.82	291	0.12	1.86	387	0.17	1.90
Comm./Industrial	1.21	5127	0.77	5127	25	0.13	0.90	55	0.28	1.06	89	0.46	1.23	123	0.63	1.40
Hotel	0.50	400	0.48	400	138	0.06	0.54	265	0.11	0.59	504	0.20	0.69	744	0.30	0.78
Agriculture	0.00	-	0.04	-	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04
Govt./Religion	0.27	-	0.69	-	-	0.06	0.75	-	0.13	0.82	-	0.19	0.88	-	0.26	0.95
	4.78		5.37			0.68	6.06		1.37	6.75		2.11	7.49		2.87	8.24

*Unit = gpd/unit

Chart 3
West Maui Water Demand Projection



The bar chart below shows projected water demands for the DWS system in West Maui. Available supply of 10 mgd is based on assumed developable yields of 3 mgd in the Honokohau Aquifer, 4 mgd in Honolua Aquifer, and 3 mgd of additional surface water treatment capability.



2. Future System Requirements and Costs

There are limited options for increasing source development in the Lahaina region. The nearby aquifers are developed or are planned to be developed to support private systems, including the 1,100-acre HCDCH Lahaina Master Planned Community. The HCDCH's plans for potable water indicate the development of at least 8 deep wells mauka of the project site at the 1,000 to 1,100 feet elevation, along with additional reservoirs and transmission lines. For the Kaanapali area, there is adequate remaining capacity to support planned developments in the area, notably the Kaanapali 2020 Development. Additional deep wells mauka of Kaanapali and Kapalua resorts could also be developed to meet future demands.

For the County in the long-term, ground-water development may still provide additional sources to meet future demands. The Honokohau aquifer system has an estimated 10 mgd of sustainable yield with no existing ground water withdrawals. Due to its remote location inland of Honokohau Bay, however, extensive transmission systems and additional storage facilities would be needed. In the Honolua aquifer system mauka of Honokahua Bay, there is approximately 4 mgd surplus sustainable yield which could be developed. With potential yields of 0.8 mgd each, additional wells could be developed in Honokahua and Honolua.

The strategy for obtaining additional supply for the municipal system involves a combination of developing surface water sources and ground water wells (West Maui Water Master Plan (1991). Table 11 presents the estimated costs for the Lahaina water system of developing the source and related improvements.

For the projected water demands, the development of additional wells may be pursued in upper Mahinahina and upper Napili which would yield 0.72 mgd each. A well field which would include the HCDCH wells has also been identified in upper Wahikuli and could provide additional municipal source capacity if necessary.

Table 11
LAHAINA WATER SYSTEM PROPOSED IMPROVEMENTS

PROJECT	COST
<u>Projects to meet 2005 demand</u>	
Honokohau A, B, C & D Wells (B well - 0.65 mgd)	14,900,000
Treatment for Honokahua A & B Wells	7,170,000
Mahinahina Well A (A well 0.72 mgd)	2,600,000
Total	\$24,670,000
<u>Projects to meet 2010 demand</u>	
Southern Alaeloa Storage Tank	\$3,270,000
<u>Projects to meet 2015 demand</u>	
Lahaina A & B Wells (A well - 0.72 mgd)	6,200,000
Napili D Well (0.72 mgd)	3,500,000
Napili Hau-Mauka Storage	1,300,000
Total	\$ 11,000,000
<u>Projects to meet 2020 demand</u>	
Honolua A Well	\$ 3,000,000

V. MAKAWAO-PUKALANI-KULA COMMUNITY PLAN REGION

A. Existing System/Service

The Makawao-Pukalani-Kula region is rural and agricultural in nature, although Pukalani and Makawao are becoming suburban communities for the employment centers in Wailuku-Kahului and the resort areas. In the Upcountry area, agriculture is still the dominant user of water.

The region is supplied primarily by surface water sources. The municipal systems include the Makawao and the Kula systems, which also service the upper portions of the Paia-Haiku community plan region (See Figure 4).

The major source for the Makawao system is the intake at the end of the Wailoa Ditch system at approximately the 1,100 foot elevation. The Kamole Water Treatment Plant with a capacity of 8 mgd is located at this site. The Wailoa Ditch system is owned by East Maui Irrigation Company and has a capacity of approximately 190 mgd.

The Awalau intake takes water from the Opana and Awalau Streams. A separate irrigation system from the Wailoa Ditch (Hawaiian Commercial and Sugar Company) supplies the County Kula Agricultural Park.

The Kula system consists of an upper and lower system. The upper system is along the 4,200 feet elevation collecting surface water from Haipuaena, Puohakamoa, and Waiakamoi Streams. The water treatment plant at Olinda has a capacity of 1.7 mgd. Major storage reservoirs include the 30 MG Waikamoi reservoirs, the 100 MG Kahakapao reservoir, a 10 MG Upper Waikamoi dam/reservoir, a lower Waikamoi dam, and a 3 MG Olinda tank.

The lower system serves the Omaopio, Olinda, and Lower Kula communities. The system consists of over 13 miles of water lines, 7 pump stations, the 50 MG Piiholo Reservoir, and the Piiholo Water Treatment Facility. The system begins at the 3,000-foot elevation and diverts water from the Haipuaena, Puohakamoa, Waiakamoi and Honomanu Streams. The Piiholo Water Treatment Facility has an average daily production of 2.5 mgd.

During dry periods, the Kula system is supplemented by water pumped from the Makawao system. With the development of the Kahakapao reservoir, the need for pumping has been significantly reduced. When needed, water is lifted 2,000 feet from Kamole Weir through a series of four pump stations to the Kula Kai Tank during dry weather periods. Various sized storage tanks are along the lower pipeline; the 2 MG Kula Kai tank is the largest. The sources for the Makawao and Kula Water Systems are shown in Table 12 below.

FIGURE 4

UPCOUNTRY
WATER SYSTEM
MAKAWAO
LOWER/UPPER KULA

Source:
County of Maui
Department of
Water Supply



WILSON OKAMOTO
& ASSOCIATES, INC.
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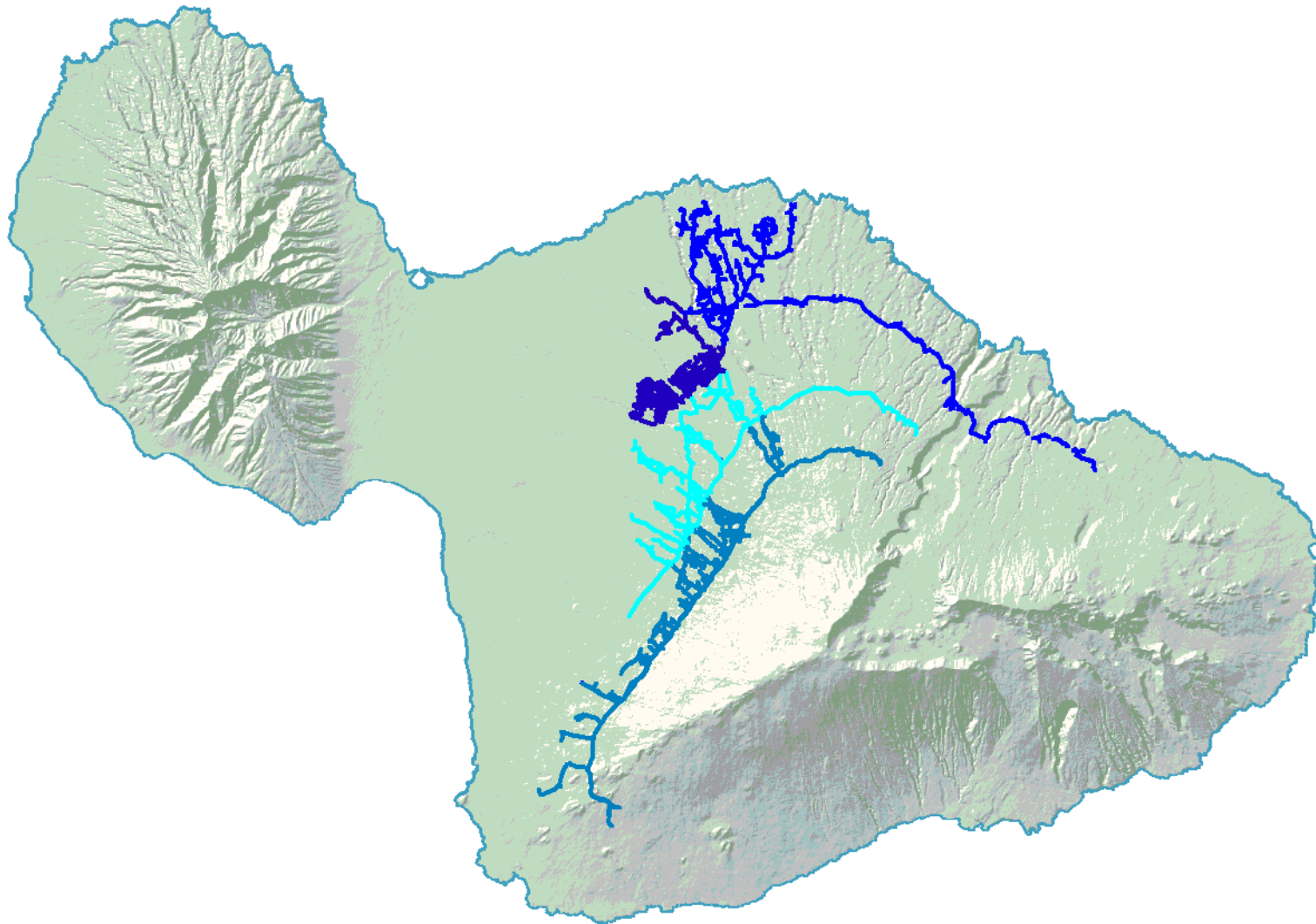


Table 12
MAKAWAO-PUKALANI-KULA SOURCES

UPCOUNTRY SOURCES	2000-2001 1,000 GALS	MGD
Kamole WTF	1,140,653	3.13
Olinda WTF	513,580	1.41
Piihola WTF	970,923	2.66
Haiku Well	50,241	0.14
Hamakuapoko 1	19,143	0.05
Hamakuapoko 2	27,576	0.08
Kaupakalua Well	139,038	0.38
Total		7.84

In 1999-2000, four ground-water sources were made available to service the Upcountry water system during drought conditions. These sources include the Haiku well, Hamakuapoko Wells 1 and 2, and Kaupakalua well, which can deliver up to 3.5 mgd, or about 40 percent of the average demand during drought conditions. The Hamakuapoko Wells are under a court order restriction limiting service during drought conditions only.

B. Existing Demand

In the Makawao-Pukalani-Kula Community Plan region, the municipal demand was 6.40 mgd in the year ending June 2001, including the communities of Makawao, Pukalani, Haliimaile, Kula, and Ulupalakua. This is an increase of 33 percent over 1991 consumption of 4.83 mgd.

Table 13
MAKAWAO-PUKALANI-KULA WATER DEMANDS (mgd)

MAKAWAO-PUKALANI-KULA SUB-DISTRICTS	1991	2001	% CHANGE
315 Makawao	0.8	0.94	17%
316 Pukalani	0.74	0.99	33%
317 Haliimaile	0.09	0.10	9%
331 Upper Kula	0.98	1.40	43%
333 Lower Kula	1.82	2.37	30%
335 Ulupalakua-Kanaio	0.13	0.19	48%
337 Kula Ag Park	0.27	0.67	146%
Total	4.83	6.40	33%

C. Existing System Constraints and Opportunities

The Upcountry area has long been faced with problems of inadequate supply during prolonged dry periods. Most of the service area is at too high an elevation to be economically supplied by water pumped from lower elevations where ground and surface water sources are more easily developed. Streamflow at the higher elevations are highly variable and subject to extremes in the hydrologic cycles. Extensive storage capacity in

reservoirs much greater than presently exists are needed to stabilize water supply, but these are costly to develop.

As with the Lahaina Water System, the cost constraint is that the surface water must be treated to increasingly stringent standards of the Safe Drinking Water Act administered by the Environmental Protection Agency (EPA). The DWS has upgraded the Kamole and Olinda Water Treatment Facilities and developed the Piipiholo Water Treatment Facility for lower Kula.

Although there is some additional water treatment capacity (the Kamole Water Treatment Plant has a capacity of 8 mgd), there is inadequate surface water supply. Present agreements with East Maui Irrigation (EMI) allow the DWS to take up to 12 mgd without prior notice, but the ditch water is heavily depended upon for sugar cane irrigation. Approximately 10,000 acres are entirely dependent on the EMI surface sources. Although the Wailoa Ditch capacity is 190 mgd, the base flow (exceeded 90 percent of the time) is 34 mgd, and flow has gone as low as 2 mgd. Especially during dry periods, all of the flow is needed, limiting available supply for the County systems, and triggering DWS calls for voluntary and mandatory conservation measures. Water restrictions prevent farmers from applying optimum levels of irrigation water to their crops and from planting new crops.

With the development of the Hamakuapoko, Kaupakalua, and Haiku wells, the Upcountry water systems can now be served with these ground-water sources. Water pumped from these wells are delivered to the ground surface at the 800 – 1200 foot elevation. When a drought condition is present, however, the water must be delivered to various Upcountry elevations up to 4,500 feet, resulting in high electrical pumping costs.

The DWS is also pursuing the development of additional source with Pookela Well and additional storage with the Kula Raw Water Reservoir.

D. Future System Service Requirements

1. Projected Demand

The projected demand for water in the Makawao-Pukalani-Kula region is based on projections supplied by the County of Maui Socio-Economic Forecast Study Update (SMS, May 2002). The projections include population growth projections to the year 2020 as well as household, employment, and visitor unit growth for each island and community plan region. Tables showing the projected unit and acreage increases are appended to this report. Existing average consumption patterns in the various land use categories are used in the projections.

Table 14 with a line graph (See Chart 4) shows the water demand projections by land use categories for the target years 2005, 2010, 2015, and 2020. Years 1990 and 2001 water use are provided for comparison and reference. Total water demand is projected to increase from 6.40 mgd in 2001 to 11.05 mgd by the year 2020, an overall increase of 4.65 mgd or approximately 72 percent of present consumption over the planning period. The greatest needs are for single-family residential use and for agriculture.

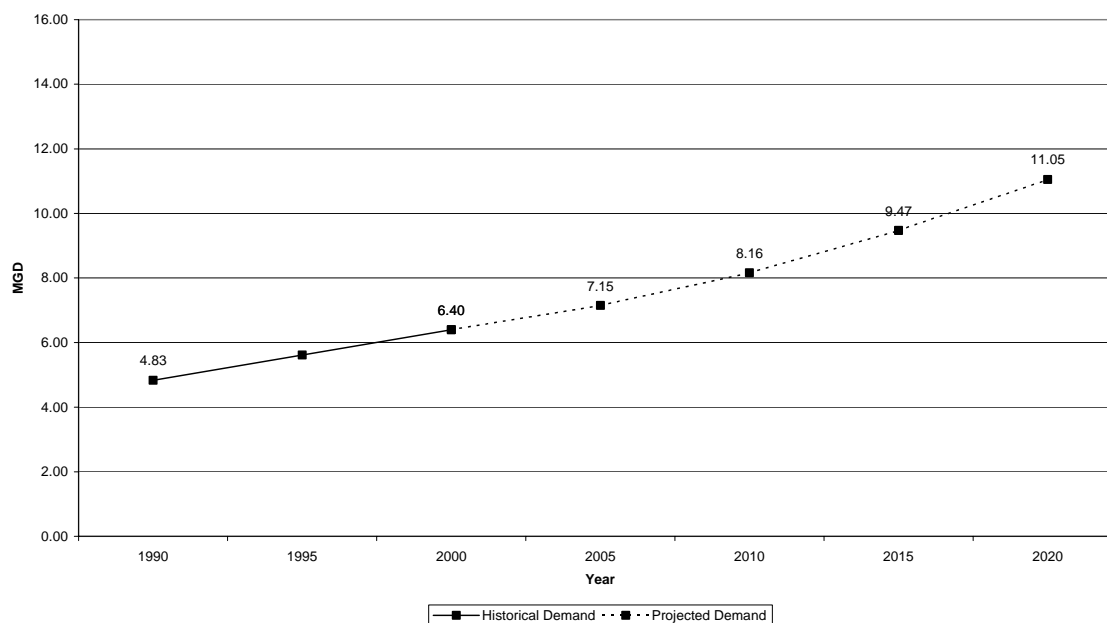
Table 14
Makawao-Pukalani-Kula Water Demand Projections

7/12/02
 WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	1990 Use (Mgd)	Ave. Use* (Mgd)	2000 Use (Mgd)	Ave. Use* (Mgd)	2005 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2010 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2015 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2020 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)
Makawao-Kula	2.15	417	2.61	474	812	0.39	3.00	1577	0.75	3.36	2344	1.11	3.72	3121	1.48	4.09
Single-Family	0.01	223	0.07	223	43	0.01	0.08	83	0.02	0.09	123	0.03	0.10	164	0.04	0.10
Multi-Family	0.21	5122	0.17	5122	8	0.04	0.21	20	0.10	0.27	32	0.16	0.33	44	0.23	0.39
Comm./Industrial	0.01	400	0.01	400	4	0.00	0.01	7	0.00	0.01	14	0.01	0.02	20	0.01	0.02
Hotel	2.41	-	3.32	-	0.00	0.28	3.60	0.00	0.56	4.16	0.00	0.85	5.01	0.00	1.13	6.14
Agriculture	0.04	-	0.23	-	-	0.02	0.25	-	0.04	0.27	-	0.06	0.29	-	0.08	0.31
Govt./Religion	4.83		6.40			0.74	7.15		1.47	8.16		2.22	9.47		2.97	11.05

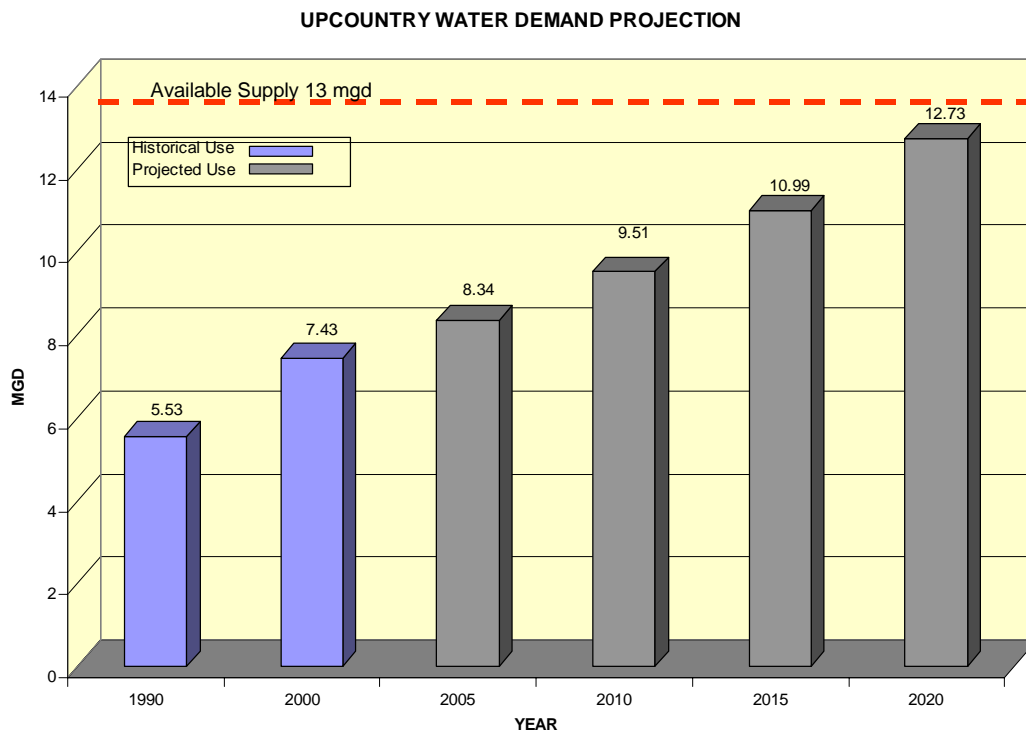
*Unit = gpd/unit

Chart 4
Makawao-Pukalani-Kula Water Demand Projection



Not included in the above demand projections are anticipated future plans for the Department of Hawaiian Home Lands (DHHL). The DHHL owns approximately 6,100 acres in Kula, and there could be development of up to 3,500 residential and 500 farm lots. Anticipated water demand could approach 5 mgd.

The bar chart below shows the Upcountry water demands, including the Makawao-Kula Community Plan region and the Haiku area. The available supply capacity of 13 mgd is a tentative estimate assuming 8 mgd of surface water treatment based on current production rates and 5 mgd from groundwater sources including the proposed Pookela Well. The surface water sources are dependent on ditch and stream flows, and some of the groundwater sources are used only to supplement surface supplies during dry periods.



2. Future System Requirements and Costs

Improvements are required to provide more stable, reliable supplies to existing Upcountry areas as well as to meet projected demands. However, there are no readily available new sources of supply, either surface or ground water. Water studies in the Upcountry area have emphasized the need for increasing storage capacity to meet future demands. As such, pumping from backup ground-water wells remain a need in times of low rainfall.

The Pookela Well development will help improve reliability of supply. A portion of the water supply from the Hamakuapoko and proposed Haiku wells may also be pumped to the Makawao system. The high costs of pumping water to the higher elevations, however,

render it unlikely that the DWS would rely on this source other than to supplement Upcountry supplies during prolonged periods of low rainfall.

It is also anticipated that the dual water system being implemented by the Soil Conservation Service and currently in its early phases of implementation will relieve some demand on potable supplies and reduce non-potable costs by eliminating the need to treat water to be used for irrigation. This will assist farmers in maintaining their agricultural operations.

Table 15
UPCOUNTRY WATER SYSTEM PROPOSED IMPROVEMENTS

PROJECT	COST
<u>Projects to meet 2005 demand</u>	
Upcountry Source Development - Pookela Well Pump Station (1.5 mgd)	650,000
Kaupakalua Well Storage	700,000
Kokomo Tank Replacement	1,500,000
Kealahou Tank	650,000
Lower Kula (Piiholo) Reservoir	31,500,000
Total	\$35,000,000
<u>Projects to meet 2010 demand</u>	
Awalau Intake (1 mgd)	2,000,000
Awalau Intake Storage (50 mg)	2,400,000
Upcountry Dual System	-
Total	\$4,400,000
<u>Projects to meet 2015 demand</u>	
Lower Kula Water System - Intake Improvements	\$12,200,000
<u>Projects to meet 2020 demand</u>	
Upcountry Source Development	-
Keokea Well Development	3,860,000
Kamole Reservoir	30,815,000
Pulehu Well and Transmission Project	1,500,000
Total	\$36,175,000

VI. PAIA-HAIKU COMMUNITY PLAN REGION

A. Existing System/Service

The Paia-Haiku Community Plan Region includes the Paia Aquifer System and the Haiku Aquifer system. Subdistricts within the region are Paia-Kuau, Kokomo Kaupakalu, Kuiaha, Haiku-Pauwela, and Paia-Hamakuapoko.

Table 16
PAIA-HAIKU SOURCES

PAIA-HAIKU SOURCES	MGD
Upper Haiku	0.10
HC&S SH32	1.46
Hamakuapoko 1&2	2.00
Total	3.56

Four major ditch-tunnel systems traverse the Haiku Aquifer System to provide an average of 164 mgd for irrigation of sugar cane in central Maui.

B. Existing Demand

In the Paia-Haiku Community Plan region, the demand was 1.47 mgd in the year ending June 2001. This is an increase of 44 percent over 1.02 mgd consumption in 1991.

Table 17
PAIA-HAIKU WATER DEMANDS (mgd)

PAIA-HAIKU SUB-DISTRICTS	1991	2001	% CHANGE
171 Paia-Kuau	0.38	0.43	14%
311 Kokomo-Kaupakalua	0.31	0.48	55%
312 Kuiaha	0.12	0.14	13%
313 Haiku-Pauwela	0.21	0.34	63%
319 Paia-Hamakuapoko		-	
Total	1.02	1.47	44%

Both Paia and Haiku aquifer systems are sparsely populated. The Paia Aquifer System is dominated by sugar cane cultivation while most of the Haiku Aquifer System consists of grassy fields and woodlands.

C. Existing System Constraints and Opportunities

The Paia-Haiku region is part of the DWS Central Maui and Upcountry system and as such shares similar system constraints and opportunities. See Sections III.C and V.C. The ten

wells proposed for use and development as part of the East Maui Water Development Plan are within the Paia and Haiku Aquifers.

D. Future System Service Requirements

1. Projected Demand

The projected demand for water in the Paia-Haiku region is based on projections supplied by the County of Maui Socio-Economic Forecast Study Update (SMS, May 2002). The projections include population growth projections to the year 2020 as well as household, employment, and visitor unit growth for each island and community plan region. Existing average consumption patterns in the various land use categories are used in the projections.

Table 18 with a line graph (See Chart 5) shows the water demand projections by land use categories for the target years 2005, 2010, 2015, and 2020. Total water demand for the region is projected to increase from 1.47 mgd in 2001 to 2.39 mgd by the year 2020, an overall increase of 0.92 mgd or approximately 63 percent of present consumption over the planning period. The greatest needs are for single-family residential use.

2. Future System Requirements and Costs

As an integral part of the East Maui Water Development Plan, the Paia-Haiku region will be serviced from the new wells. Initially, modifications are proposed to the existing system at Paia and Spreckelsville to supply these areas as well as portions of Kahului with the 2.0 mgd wells being developed. A new 16-inch pipeline would be developed parallel to Kailua Gulch from Sunnyside Road to Hana Highway.

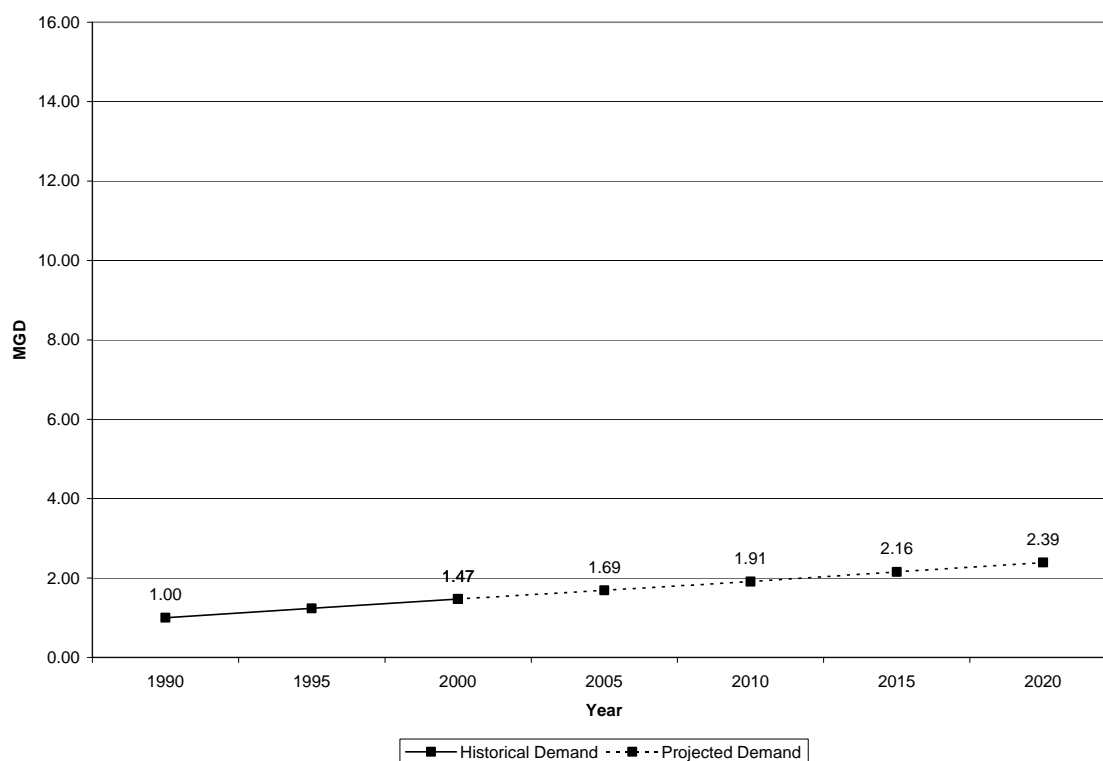
Table 18
Paia-Haiku Water Demand Projections

7/12/02
WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	2000		2005			2010			2015			2020		
	Use	Ave.	Increase	Added	Total	Increase	Added	Total	Increase	Added	Total	Increase	Added	Total
	(Mgd)	Use*		(Mgd)	(Mgd)		(Mgd)	(Mgd)		(Mgd)	(Mgd)		(Mgd)	(Mgd)
Paia-Haiku	1.11	410	419	0.17	1.28	814	0.33	1.44	1210	0.50	1.61	1611	0.66	1.77
Single-Family	0.04	560	22	0.01	0.06	43	0.02	0.07	64	0.04	0.08	85	0.05	0.09
Multi-Family	0.08	6000	6	0.04	0.12	15	0.09	0.17	24	0.14	0.23	33	0.20	0.28
Comm./Industrial	-	350	4	0.00	0.00	7	0.00	0.00	14	0.00	0.00	20	0.01	0.01
Hotel	0.19	-	0.00	0.00	0.19	0.00	0.00	0.19	0.00	0.00	0.19	0.00	0.00	0.19
Agriculture	0.04	-	-	0.00	0.04	-	0.01	0.04	-	0.01	0.05	-	0.01	0.05
Govt./Religion	1.47			0.22	1.69		0.45	1.91		0.69	2.16		0.93	2.39

*Unit = gpd/unit

Chart 5
PAIA-HAIKU WATER DEMAND PROJECTION



VII. HANA COMMUNITY PLAN REGION

A. Existing System/Service

The Hana Community Plan Region includes the serviced area between Kaeleku Agricultural Park and Hamoa Town where water supply is provided by the Maui County Department of Water Supply, Hana Water Resources, and Hana Water Company.

The Hana Water Resources system (See Figure 5) serves the Hotel Hana-Maui, Hana Ranch and estates, and commercial establishments in Hana. Its system consists of two deep wells (Wananalua Well and its inoperable back-up, Helani Well), a 500,000 gallon steel storage tank, and distribution lines ranging in size from 4-inches to 12-inches. Average daily pumpage is approximately 158,000 gallons.

The Hana Water Company system serves the Kaeleku Agricultural Park, one-half mile south of Hana Airport. The system consists of a single deep well, 2,500-, 30,000-, and 50,000-gallon storage tanks, and distribution lines ranging in size from 4-inches to 6-inches. The system distributes about 87,000 gallons per day.

The County Department of Water Supply system consists of three deep wells (Wakiu A and B and Hamoa Well), 500,000-, 190,000, and 40,000-gallon storage tanks in Hamoa and Hana, and a surface water source located on Wailua Stream. One of the deep wells, however, Wakiu Well A, has been out of service since 1997 and the surface water source of Wailua Stream is presently not used. The system pumps out an average of 168,000 gallons per day.

The sources for the Hana Water System from the Department of Water Supply are shown in Table 19 below.

Table 19
HANA SOURCES

HANA SOURCES	2000-2001 1,000 GALS	MGD
Hamoa 597	31,602	0.09
Keanae 592	12,607	0.03
Wakiu 550	54,934	0.15
Total	99,143	0.27

B. Existing Demand

In the Hana Community Plan region, the DWS demand was 0.20 mgd in the year ending June 2001. This amounts to a 0.5 percent increase over the 0.19 mgd consumption in 1991.

FIGURE 5

EAST MAUI
WATER SYSTEM

Source:
County of Maui
Department of
Water Supply



WILSON OKAMOTO
& ASSOCIATES, INC.
ENGINEERS - PLANNERS

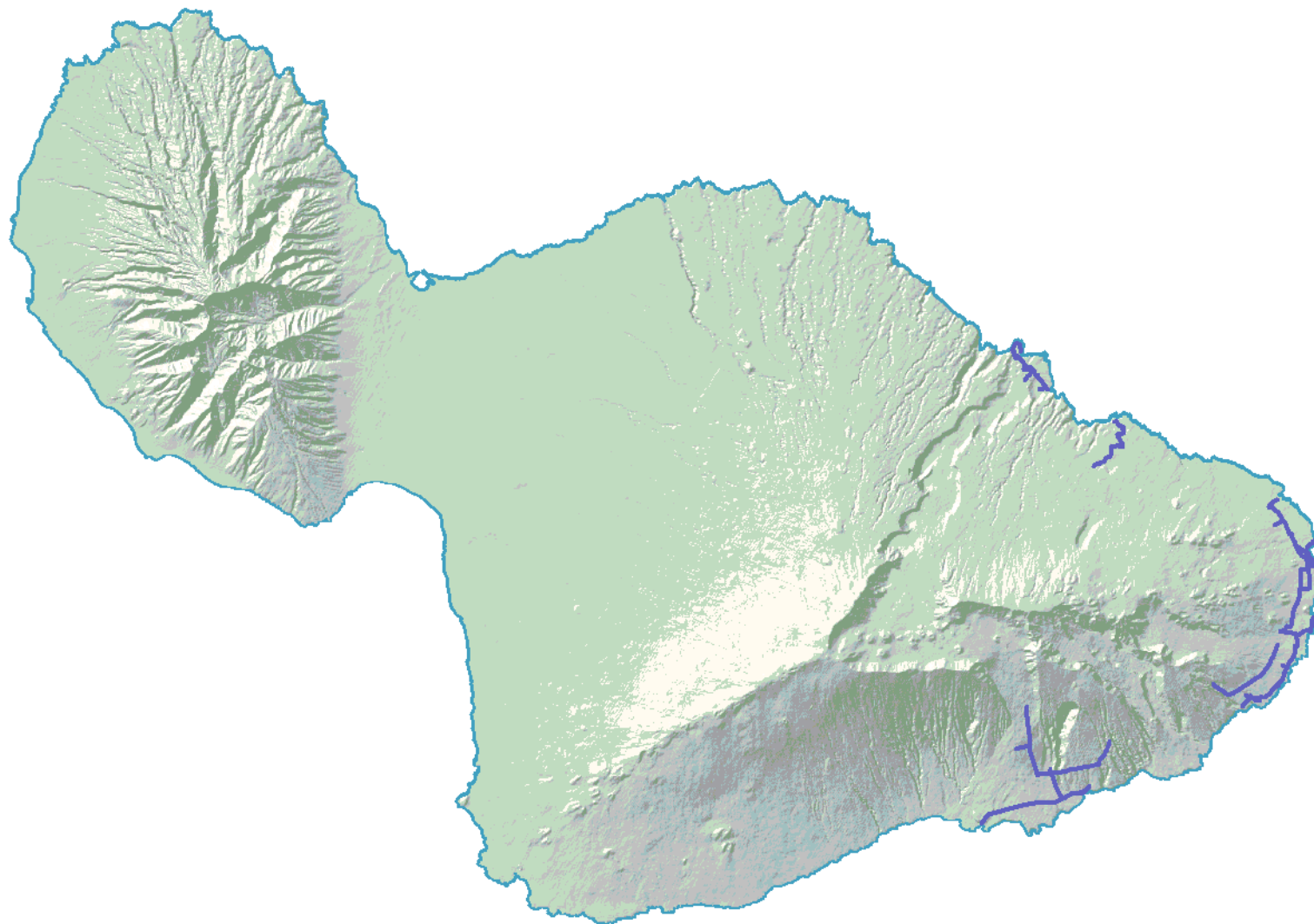


Table 20
HANA WATER DEMANDS (mgd)

HANA	SUBDISTRICTS	1991	2001	% CHANGE
911	Hana	0.15	0.17	14%
913	Nahiku	0.01	0.01	10%
915	Keanae	0.03	0.02	-27%
917	Kaupo	0	0.00	
	Total	0.19	0.21	9%

C. Existing System Constraints and Opportunities

The major deficiency of the County Department of Water Supply system is the need to back up both ends of the system between Wakiu and Hamoa. DWS is adding a well at Hamoa, and improving transmission between the Hamoa and Wakiu wells. The cracked well casing at Wakiu Well A which has rendered the well inoperable since 1997 also requires repair. Also, many areas served by the County system have inadequate line capacity to provide fire flow.

Improvements recently completed by the County DWS include replacing existing lines in Hana Town along portions of Hana Highway, Uakea Street and Keawa Place with a 12-inch ductile iron pipeline. In addition, planned improvements under design in Hamoa include replacing 5,500 feet of the existing 1- to 3-inch line in Haneoo Road from the southern terminus of the road to Koki Park with an 8-inch main.

Should the need for more water arise, revival of the old Wailua intake on Wailua Stream could be tapped by the DWS to provide an additional 100,000 gallons per day to their supply, but water treatment would be required. Additional well development could also be pursued given the ample sustainable yield in the aquifers in the area.

D. Future System Service Requirements

1. Projected Demand

The projected demand for water in the Hana region is based on projections supplied by the County of Maui Socio-Economic Forecast Study Update (SMS, May 2002). The projections include population growth projections to the year 2020 as well as household, employment, and visitor unit growth for each island and community plan region. Existing average consumption patterns in the various land use categories are used in the projections.

Table 21 with a line graph (See Chart 5) shows the water demand projections by land use categories for the target years 2005, 2010, 2015, and 2020. Total water demand for the region is projected to increase from 0.2 mgd in 2001 to 0.33 mgd by the year 2020, an overall increase of 0.13 mgd or approximately 65 percent of present consumption over the planning period. The greatest needs are for single-family residential use.

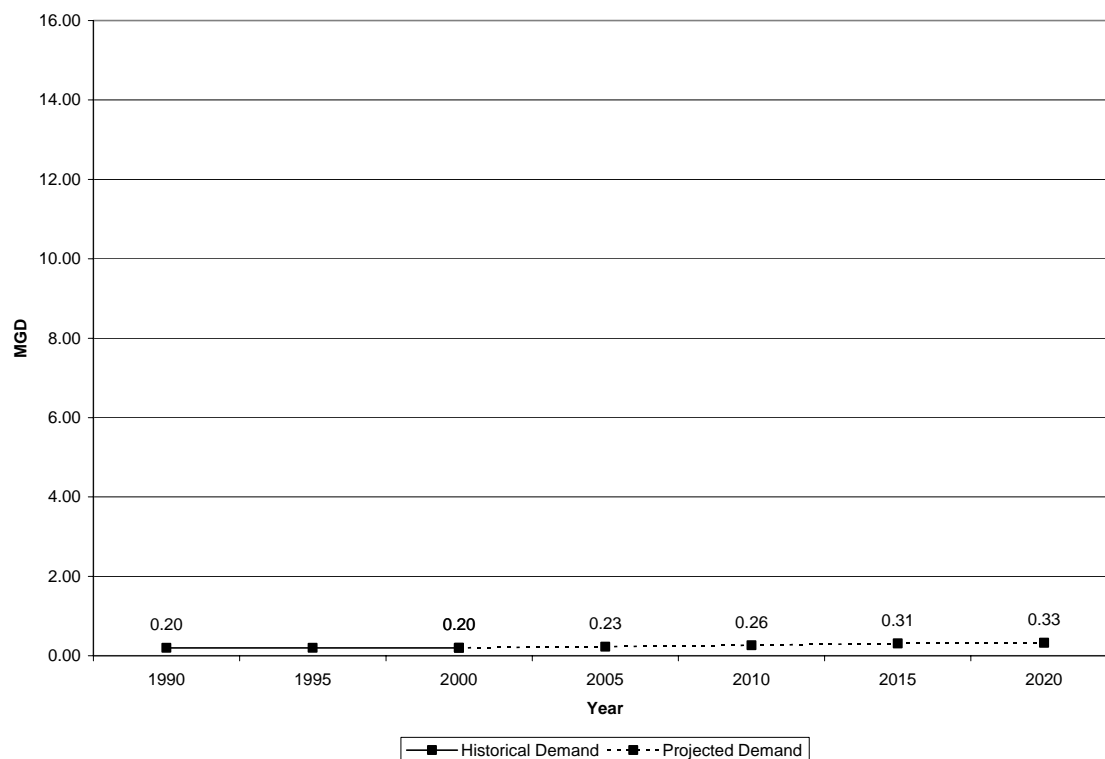
Table 21
Hana Water Demand Projections

7/12/02
WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	2000 Use (Mgd)	Ave. Use* (Mgd)	2005 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2010 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2015 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)	2020 Increase (Mgd)	Added Use (Mgd)	Total Use (Mgd)
Hana	0.13	336	66.00	0.02	0.15	126	0.04	0.17	188	0.06	0.20	251	0.08	0.22
Single-Family	0.00	560	3.00	0.00	0.00	7	0.00	0.00	10	0.01	0.01	13	0.01	0.01
Multi-Family	0.01	6000	1.00	0.01	0.02	2	0.01	0.02	4	0.02	0.03	4	0.02	0.03
Comm./Industrial	0.01	350	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
Hotel	0.01	-	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
Agriculture	0.04	-	-	0.00	0.04	-	0.01	0.05	-	0.01	0.05	-	0.01	0.05
Govt./Religion	0.20			0.03	0.23		0.06	0.26		0.10	0.31		0.12	0.33

*Unit = gpd/unit

Chart 5
Hana Water Demand Projection



2. Future System Requirements and Costs

The need for backup and redundancy for all areas of the system are being addressed by improved transmission between Wakiu and Hamoa, and the addition of another well at Hamoa. The Wakiu and Hamoa portions of the system are planned to be connected, and one additional backup well will be added to supplement the Hana System.

Table 22
HANA WATER SYSTEM PROPOSED IMPROVEMENTS

PROJECT	COST
<u>Projects to meet 2005 demand</u>	
Keanae Well 2	200,000
Hana Source Development - Hamoa Well 2	1,250,000
Hana Hamoa Waterline Improvements (12,000 ft of 8-inch pipe)	2,500,000
Total	\$3,950,000
<u>Projects to meet 2010 demand</u>	
Nahiku Water Source Improvements (0.02 mgd)	1,370,000
Upper Keanae Tank	600,000
Kailua Storage Improvemnts	450,000
Hamoia-Koali Waterline (17,000 ft of 6- and 8-inch pipe)	665,000
Kailua Transmission Improvements	750,000
Kaupo Waterline Improvements - Tank to Highway (8,000 ft of 8-inch pipe)	1,140,000
Total	\$4,975,000

VIII. MOLOKAI COMMUNITY PLAN REGION

A. Existing System/Service

The Molokai Community Plan Region encompasses the entire island of Molokai. Water district sub-areas under the Department of Water Supply include Kawela-Kaunakakai, Ualapue, Kalae, and Halawa on the east side of the island (See Figure 6). The Department of Hawaiian Home Lands system services the homestead lots, while the Molokai Irrigation System and the Department of Agriculture systems in central Molokai serve agricultural interests. Kaluakoi, Molokai Ranch, and Alpha, Inc., each of whom have independent water systems, privately own the west side of Molokai.

Nearly all of Molokai's water comes from wells dug to tap the basal reservoirs (see Figure 7, Island of Molokai Hydrologic Units). The west and central sections of the island, which require the most water, have aquifer systems that produce relatively low amounts of potable water. At the west end, Kaluakoi and Punakou aquifers have CWRM-established developable yields of 2 mgd each. In the Central Sector, Hoolehua and Manawainui aquifers have 2 mgd each, while Kualapuu has 5 mgd of developable yield. In the Southeast Sector, Kamiloloa and Kawela have 3 mgd and 5 mgd, respectively. Some of the surface water resources have been utilized, mostly the 2.7 mgd that the Molokai Irrigation System diverts from the northeast sector. Total sustainable yield for the island of Molokai is 81 mgd.

The sources for the Molokai Water System from the Department of Water Supply are shown in Table 23 below.

Table 23
MOLOKAI SOURCES

MOLOKAI SOURCES	2000-2001 1,000 GALS	MGD
Kawela 551	85,182	0.23
Kawela 552	888	0.00
Ualapue 553	37,593	0.10
Ualapue 554	37,578	0.10
Kualapuu	253,190	0.69
Waikalae Tunnel	3,915	0.01
Total		1.15

B. Existing Demand

In the Molokai Community Plan region, the DWS demand was 0.93 mgd in the year ending June 2001. This is an increase of 58 percent over 0.59 mgd consumption in 1991.

FIGURE 6

MOLOKAI
WATER SYSTEM

Source:
County of Maui
Department of
Water Supply



WILSON OKAMOTO
& ASSOCIATES, INC.
ENGINEERS - PLANNERS

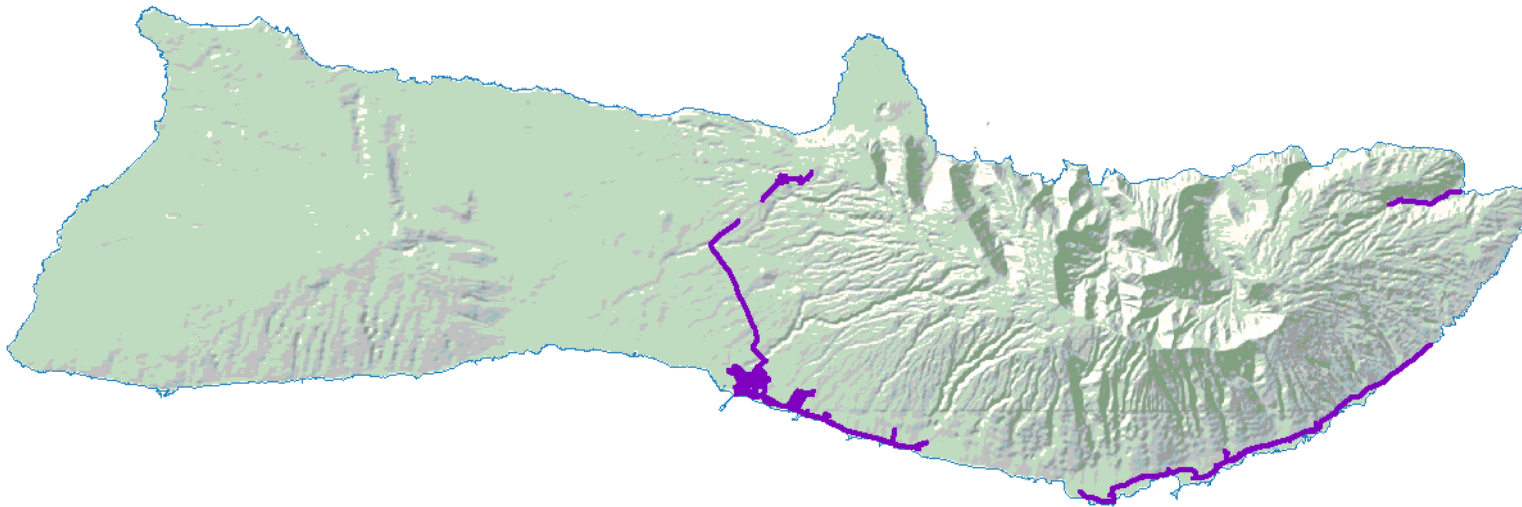


FIGURE 7

ISLAND OF MOLOKAI
HYDROLOGIC UNITS

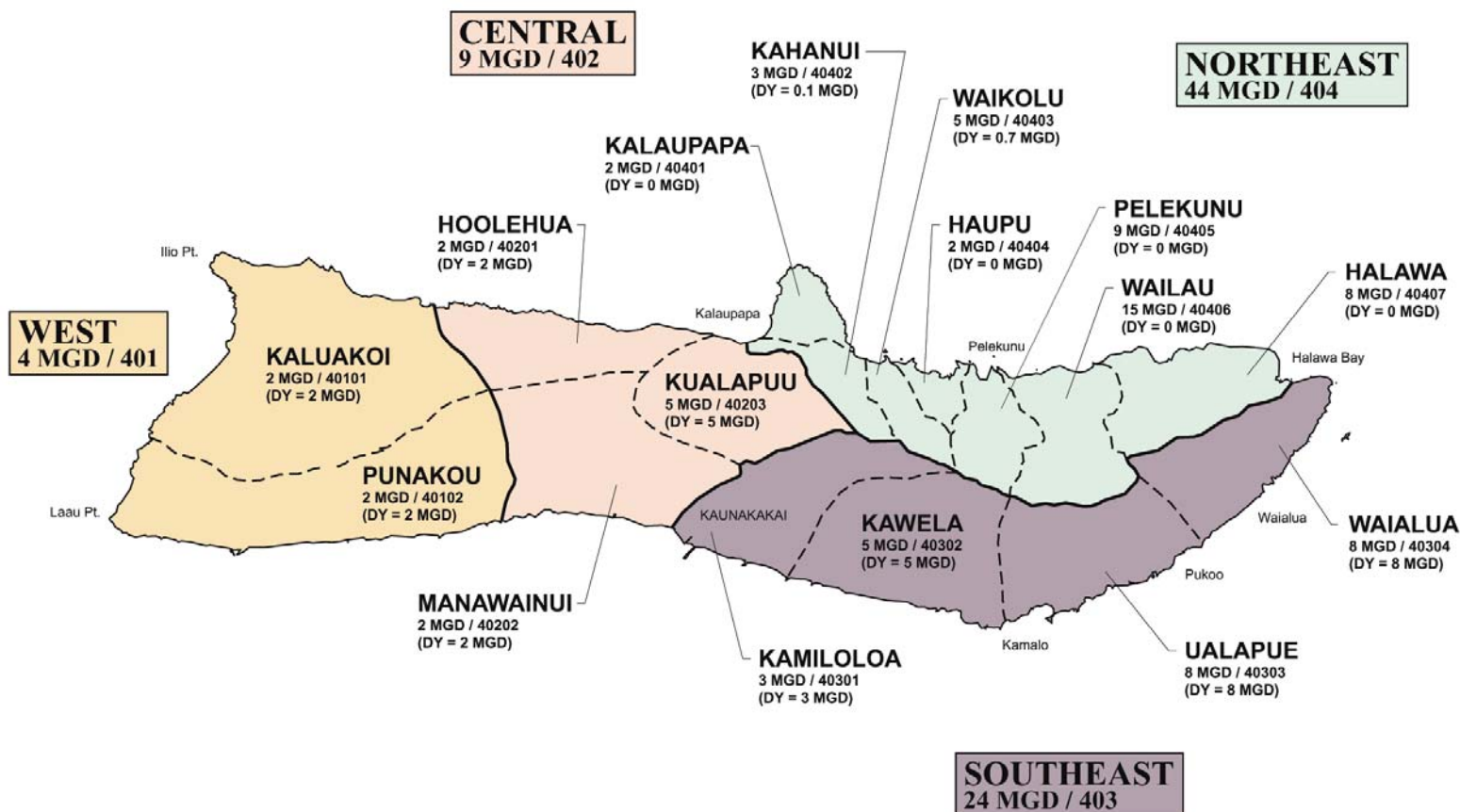
Source:
State of Hawaii
Commission on
Water Resource
Management

ISLAND OF MOLOKAI

TOTAL SY = 81 MGD

TOTAL SY = 38 MGD

HYDROLOGIC UNITS Sustainable Yield / Aquifer Code



DY= DEVELOPABLE YIELD

1" = 5 MILES

Table 24
MOLOKAI WATER DEMANDS (mgd)

MOLOKAI SUB-DISTRICTS	1991	2001	% CHANGE
711 Kawela-Kaunakakai	0.41	0.70	72%
713 Ualapue	0.14	0.20	43%
715 Kalae	0.04	0.03	-33%
717 Halawa	0	0.00	
Total	0.59	0.93	58%

C. Existing System Constraints and Opportunities

In July 1992, the island of Molokai was designated as a Water Management Area by the State Commission on Water Resource Management (CWRM). This designation meant that all existing uses needed to be permitted, and any proposed uses or withdrawals from water sources would require the approval of the CWRM.

In October 1992, the Molokai Working Group was convened by the CWRM to recommend a plan for water development on Molokai that assists the County and Molokai community in developing its Water Use and Development Plan. The Working Group, which included representatives from government, community, development, agricultural and homestead interests met through 1993 and in 1995-1996 to develop and refine their recommendations.

The Final Report of the Molokai Working Group (April 1996) cites that agriculture will continue to be the economic and cultural “heart” of Molokai, but that the capacity of the aquifers should be treated conservatively and protected until more precise determinations can be made.

The following are some the Working Group’s findings on Molokai’s water system:

- The sustainable yield for the Kualapuu Aquifer appears to have been fully allocated in 1996.
- For planning purposes, an islandwide developable yield of 41.5 mgd is established, including 8 mgd of brackish water and 33.5 mgd of potable water.

The Working Group’s estimates of existing uses, future demand and supply found the following (see Table 25):

- 1996 groundwater permitted usage is 8.59 mgd.
- 1996 surface water reported usage is 2.96 mgd.
- The Department of Hawaiian Home Lands has a groundwater reservation of 2.90 mgd from the Kualapuu Aquifer System.
- 1993 projected potable water for 2010 is estimated at 11.55 mgd.
- 1993 projected non-potable water use for 5-10 years is estimated at 20.52 mgd.
- 1993 projected non-potable water use from 2010 to “build out” is estimated at 42.90 mgd.
- Current use plus 1993 projections of water use exceed supply.

Table 25
MOLOKAI WORKING GROUP PROJECTIONS

AQUIFER	USER	1993 GROUND- WATER USE (MGD)	2010 POTABLE PROJECTED USE (MGD)
CENTRAL SECTOR			
Manawainui System	Hawaiian Research	0.56	0.56
Kualapuu System	County DWS	0.59	0.94
	DHHL	0.38	0.84
	Kaluakoi Resort	0.82	2.14
	Other State Projects	0.00	0.11
	Palaau Industrial Park	0.00	0.20
	Others(Kualapuu, Kalae,Kipu)	0.00	0.20
	Subtotal	1.79	4.43
NORTHEAST SECTOR			
Kahanui System	National Park Service	0.22	0.22
Waikolu System	DOA Molokai Irrigation Sys	1.13	2.70
SOUTHEAST SECTOR			
Kamiloloa System	Hawaiian Research	0.26	0.26
Kawela System	County DWS	0.32	0.32
	Kawela Plantation	0.16	0.40
	Kamalo Ranch	0.04	0.04
	Subtotal	0.52	0.76
Ualapue System	County DWS	0.18	0.18
	Kamalo Ranch	0.22	0.22
	Place, M.J.	0.22	0.22
	Subtotal	0.62	0.62
WEST SECTOR			
	Alpha USA		2.00
	TOTAL	5.10	11.55

It may be noted that the Working Group's projections are based on pending projects and anticipated use, rather than on use trends and growth projections. The DWS is employing trend analysis of their systems in developing forecasts as part of the Water Use and Development Plan.

D. Future System Service Requirements

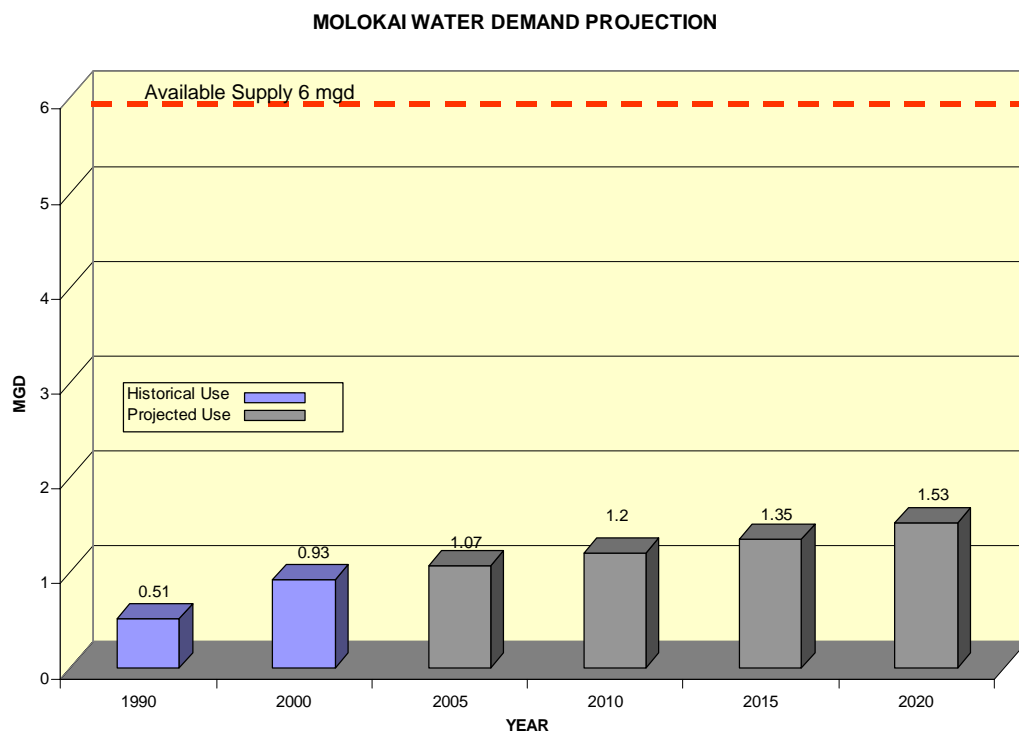
1. Projected Demand

The projected demand for water on Molokai is based on projections supplied by the County of Maui Socio-Economic Forecast Study Update (SMS, May 2002). The projections include population growth projections to the year 2020 as well as household, employment, and visitor unit growth for each island and community plan region. Tables showing the projected unit and acreage increases are appended to this report. Existing average consumption patterns in the various land use categories are used in the projections.

Table 26 with a line graph (See Chart 6) shows the water demand projections by land use categories for the target years 2005, 2010, 2015, and 2020. Total water demand is projected to increase from 0.93 mgd in 2001 to 1.53 mgd by the year 2020, an overall increase of 0.60 mgd or approximately 64 percent of present consumption over the planning period. The greatest need is for single-family residential use.

The DWS serves the Kaunakakai-Kawela-Ualapue area of Molokai. Based on 1,282 residential water services with an average household size of 3.1, the municipal system serves approximately 3,794 persons, or 54 percent of the 7,404 population on Molokai. This proportion of water use for single-family residences was applied before calculating the projected increases in growth.

The bar chart below shows the projected water demands for the DWS system on Molokai. Available supply of 6 mgd is a tentative estimate based on assumed developable yields and restrictions from the Molokai Working Group Plan for Kualapuu (1 mgd), Kamiloloa (1 mgd), Kawela (1.5 mgd), and Ualapue (2.5 mgd) Aquifers.



2. Future System Requirements and Costs

The Final Report of the Molokai Working Group addressed future water needs. The four remaining “tough” issues to be resolved include: 1) ground-water and wellhead protection for Molokai; 2) Hawaiian and DHHL rights to water; 3) streamflow protection and possible restoration; and 4) Kualapuu wellfield protection. The following specific recommendations were made for the island’s Aquifer Sectors:

Northeast Aquifer Sector: 1) new water sources from undeveloped areas should be held in reserve; 2) existing uses should continue if they are consistent with the State Water Code; and 3) use of Molokai Irrigation System’s capacity should be monitored, while development of additional water should not be allowed unless assessments indicate no further impact to the natural ecosystems.

Central Aquifer Sector: 1) ground-water allocations should coincide with 2010 projections subject to ongoing aquifer studies; 2) limit withdrawal from Kualapuu Aquifer to 5.0 mgd; 3) the 5.0 mgd limit for Kualapuu may be exceeded by up to 2 mgd for DHHL use if aquifer water quality not threatened.

Southeast Aquifer Sector: 1) limit ground-water withdrawal to 33% of developable yield subject to verification of existing users and water use permits; 2) withdrawals should not diminish supplies for traditional uses such as taro and fishponds – baseline water requirements for these uses are needed; and 3) additional water should be provided to existing residences not yet served.

West Aquifer Sector: promote reforestation of Maunaloa’s mountains for long term water resource enhancement.

The DWS’s near term plans include a backup well for the Kaunakakai-Kawela system in the Kawela aquifer (1 mgd capacity well). The existing Kawela well has inadequate capacity to backup the system should the Kualapuu well malfunction. If emergency service is needed, backup could be provided by the DHHL and Molokai Irrigation System. However, the additional DWS well would provide the needed backup for reliability and to distribute some pumpage from the more heavily used Kualapuu aquifer.

Table 26
Molokai Water Demand Projections

7/12/02

WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	2000 Use (Mgd)	Ave. Use*	2005 Increase	Added Use (Mgd)	Total Use (Mgd)	2010 Increase	Added Use (Mgd)	Total Use (Mgd)	2015 Increase	Added Use (Mgd)	Total Use (Mgd)	2020 Increase	Added Use (Mgd)	Total Use (Mgd)
Molokai	0.62	495	171	0.08	0.71	326	0.16	0.78	505	0.25	0.87	698	0.35	0.97
Single-Family	0.04	560	16	0.01	0.05	30	0.02	0.06	47	0.03	0.07	65	0.04	0.08
Multi-Family	0.08	6000	6	0.04	0.11	12	0.07	0.15	19	0.11	0.19	27	0.16	0.24
Comm./Industrial	0.04	350	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04
Hotel	0.03	-	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03
Agriculture	0.12	-	-	0.01	0.13	-	0.02	0.14	-	0.04	0.15	-	0.05	0.17
Govt./Religion	0.93			0.14	1.07		0.27	1.20		0.43	1.35		0.60	1.53

*Unit = gpd/unit

Chart 6
Molokai Water Demand Projection

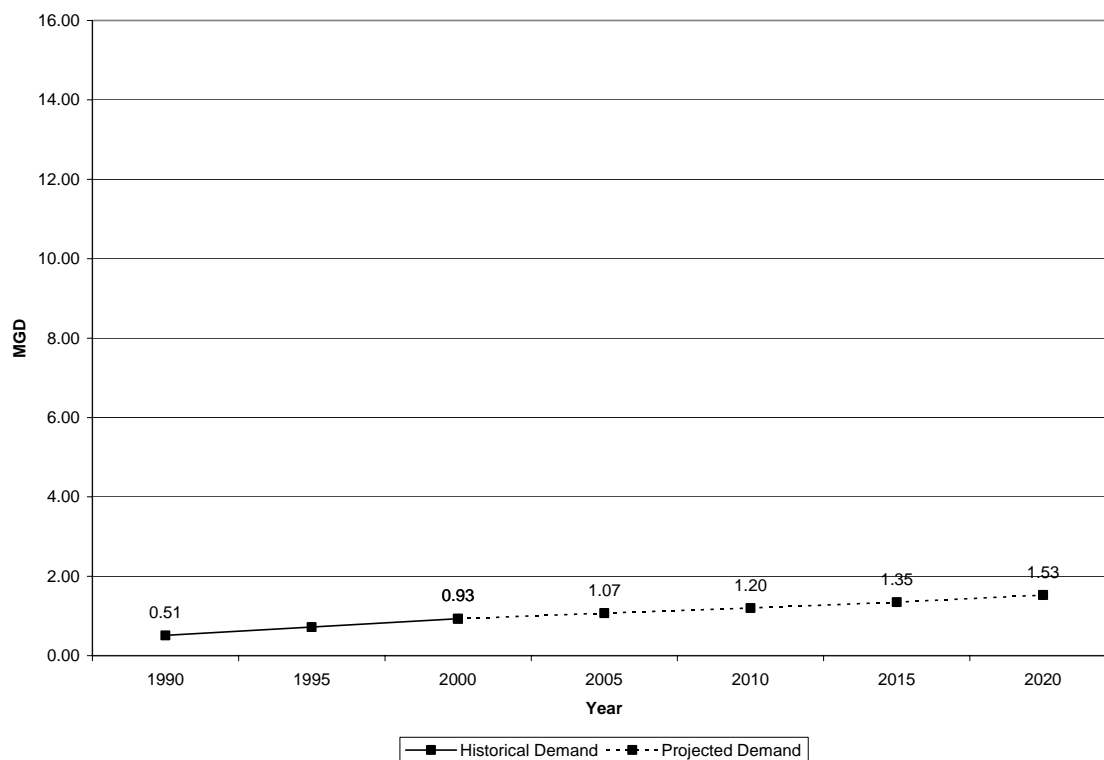


Table 27
MOLOKAI WATER SYSTEM PROPOSED IMPROVEMENTS

PROJECT		COST
<u>Projects to meet 2005 demand</u>		
Kaunakakai Well No. 2 (1 mgd)		2,800,000
Kualapuu Well Tank Enlargement (add 0.5 mg)		200,000
Kamiloloa-Kawela Transmission Improvements (15,600 ft of 12-inch pipe)		2,272,000
Total		\$5,272,000
<u>Projects to meet 2015 demand</u>		
Connect Kaunakakai-Kawela & Ulapue Systems (31,000 ft of 12-inch pipe)		\$4,460,000

IX. LANAI COMMUNITY PLAN REGION

A. Existing System/Service

The Lanai Community Plan Region encompasses the entire island of Lanai. The primary sources consist of six (6) wells tapping the aquifers in the mountainous central sector of the island (see Figure 8, Island of Lanai Hydrologic Units). These wells pumped a total of 1.84 mgd in 2001 to service Lanai City, Koele and Manele Resort areas, and Kaunalapau. The distribution of this water included 0.65 mgd to Lanai City and the Koele Hotel, 1.17 mgd to the Manele Resort area, diversified agriculture and Airport, and 0.01 mgd to Kaunalapau. There are no County DWS systems on Lanai.

Although Lanai has been determined to have a 6.0 mgd sustainable yield by the CWRM, a management guideline limit of 4.3 mgd was established, which would be reconsidered when water usage reached that level.

Table 28
LANAI SOURCES

LANAI SOURCES	2001 1,000 GALS	MGD
Well No. 1	143,901	0.39
Well No. 9	82,934	0.23
Well No. 3 (City)	25,011	0.07
Well No. 4	200,678	0.55
Well No. 6	189,385	0.52
Well No. 8 (City)	28,004	0.08
Total	669,913	1.84

B. Existing and Projected Demand

The Lanai Water Working Group was initially formed from the Water Subcommittee of the County Council's Committee on Human Services, Water, and Agriculture, with the addition of two Lanai residents. The Lanai Working Group was charged with gathering water use data, developing projections of future water demand, identifying issues in water use and development, recommending alternative strategies, and preparing an update of the Water Use and Development Plan for Lanai. The Final Report of the Lanai Working Group was prepared in February 1997. Since 1997, the Working Group has been reconvened under the auspices of DWS as the Lanai Water Advisory Committee.

The 1995 consumption determined from billing records was 1.57 mgd. The corresponding pumping (supply) rate was 1.70 mgd, indicating a system loss of 7.89 percent of the pumping rate. This was a significant improvement over the 23 percent loss in 1993 due to improved water system management by the Lanai Company.

FIGURE 8

ISLAND OF LANAI
HYDROLOGIC UNITS

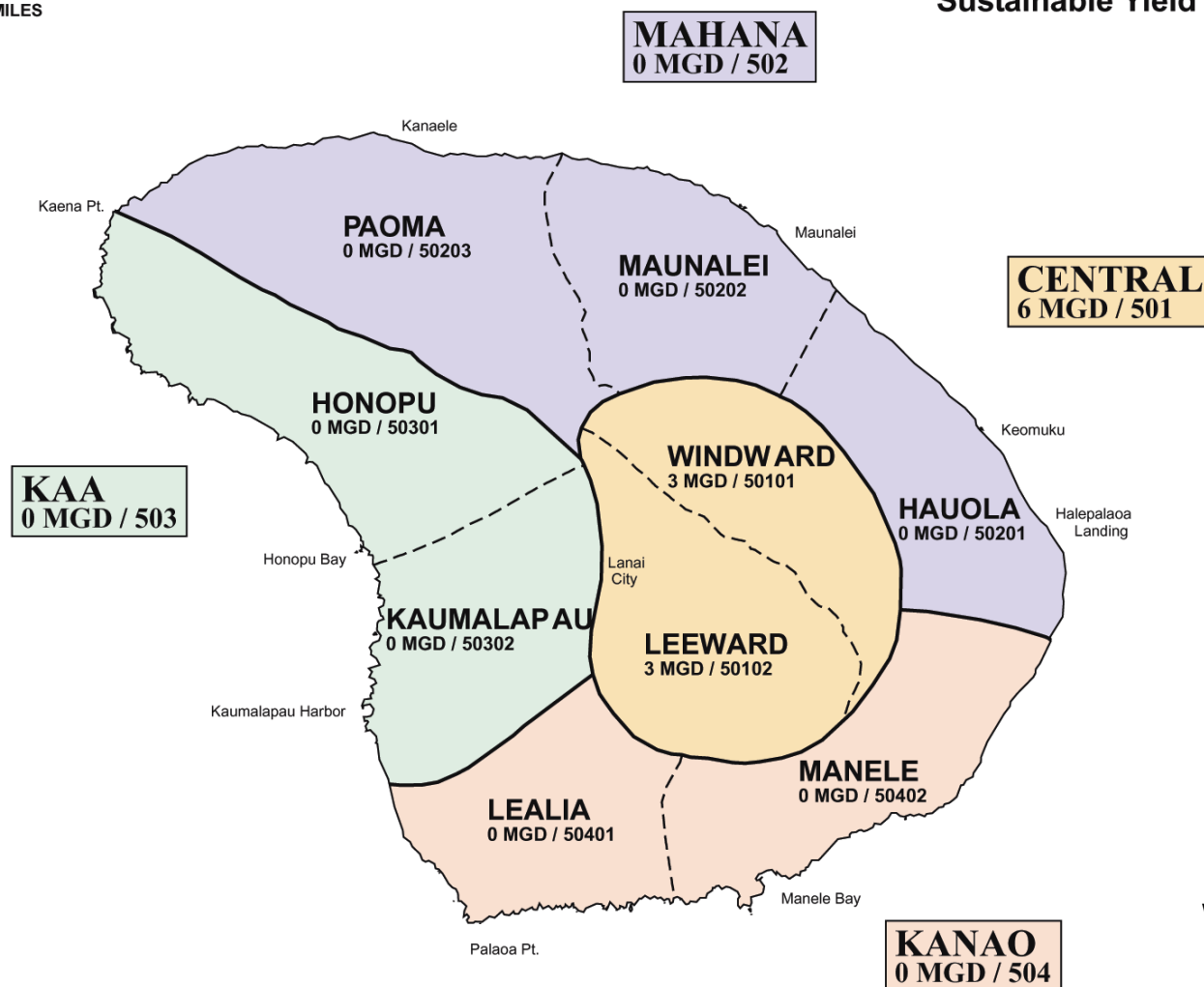
Source:
State of Hawaii
Commission on
Water Resource
Management



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& ASSOCIATES, INC.
ENGINEERS - PLANNERS

ISLAND OF LANAI
TOTAL = 6 MGD
HYDROLOGIC UNITS
Sustainable Yield / Aquifer Code

1" = 3 MILES



Source:
State of Hawaii
Commission on
Water Resource
Management

The unit consumption for residential units in Lanai City averages 316 gpd/unit, comparable to Paia, Maui, and normal for this community that is predominantly of old plantation architecture without extensive landscape development. Table 29 developed by the Lanai Working Group shows 1995 use, 2010 projection, and a total future requirement.

Table 29
1995 Use and Projected Demands for Lanai

LAND USE	1995 (MGD)	2010 (MGD)	TOTAL FUTURE
Residential	0.27	0.41	0.49
Agriculture	0.22	0.50	1.50
Commercial & Institutional	0.38	0.44	0.44
Light Industrial	0.00	0.09	0.09
Kaunalapau Harbor	0.01	0.01	0.01
Lanai Airport	0.01	0.01	0.01
Manale Project District	0.08	0.68	1.03
Manele Golf Course	0.51	0.65	0.65
Manele Effluent	0.05	0.07	0.14
Koele Project District	0.10	0.20	0.42
Koele Golf Course (effluent)	0.17	0.25	0.25
Subtotal Groundwater	1.57	2.99	4.64
System losses	0.13	0.41	0.63
Total Groundwater	1.70	3.40	5.28
Total Effluent	0.22	0.32	0.44
Total Water Demand	1.92	3.72	5.72

C. System Constraints and Opportunities

With a limited supply of water to support existing and future development, protection of the island's water resources is a principal concern of the water use plan. Watershed management is critical to assure continued recharge of the aquifers. Due to limited rainfall and the low sustainable yield, fog drip is relied on to recharge the aquifer. The loss of fog-drip vegetation in high elevation areas could reduce the available groundwater. The introduction of pigs, goats, axis deer and mouflon sheep in successive periods has been detrimental to the vegetation. Trees planted in the 1920s and 1930s that contribute to recharge capacity are aging and more susceptible to invasive plants and insects.

The Final Report of the Lanai Working Group advocates a strong watershed management program as essential to its water resources. Mechanisms include the Tri-Isle (Maui County) Resource Conservation and Development District (RC&C) for cooperative cost-

sharing and technical support programs, the Forest Stewardship Program sponsored by the U.S. Forest Service through the State Division of Forestry and Wildlife, and private efforts. A forest stewardship plan was prepared for the Lanai Company in 1996 to address the concerns.

Specific recommendations of the Working Group include the following:

1. Establish a watershed management program on an ongoing basis with special emphasis on preserving the native ecosystem and the fog drip component of recharge in the watershed.
2. Adopt the revised well operating management guidelines as mandatory.
3. Implement water conservation measures aimed at reducing outside use as the strategy for meeting demand. Inventory all irrigated acreage and water application rates, retrofit and plan for recycling and reusing water from water features within the resort.
4. Then, consider desalination as required to meet future demand for new hotels and resort facilities. Desalination costs shall not be passed on to residential and agricultural consumers.
5. Implement and maintain dual water systems in Manele.

D. Future Requirements and Costs

The Lanai Water Advisory Committee is working on final agreement for the amount of use that would trigger the required development of new sources. The State's numerical model indicated that 6 mgd sustainable yield was available, but since the distribution of withdrawals was not optimal, the full sustainable yield amount cannot be withdrawn without damage to the aquifer. The group is considering a water use trigger of 3.5 mgd at which point new source development will be required, or when operational guideline triggers have been reached, whichever occurs first.

Sustainable yield is also dependent upon the Lanaihale watershed remaining intact in its current state or better. The Lanai Water Advisory Committee will continue to monitor progress on forest protection, to serve as a member of the Lanai Forest and Watershed Partnership which it co-founded to ensure that the watershed is protected.

**WATER SYSTEMS APPENDIX
DEMAND PROJECTION TABLES**

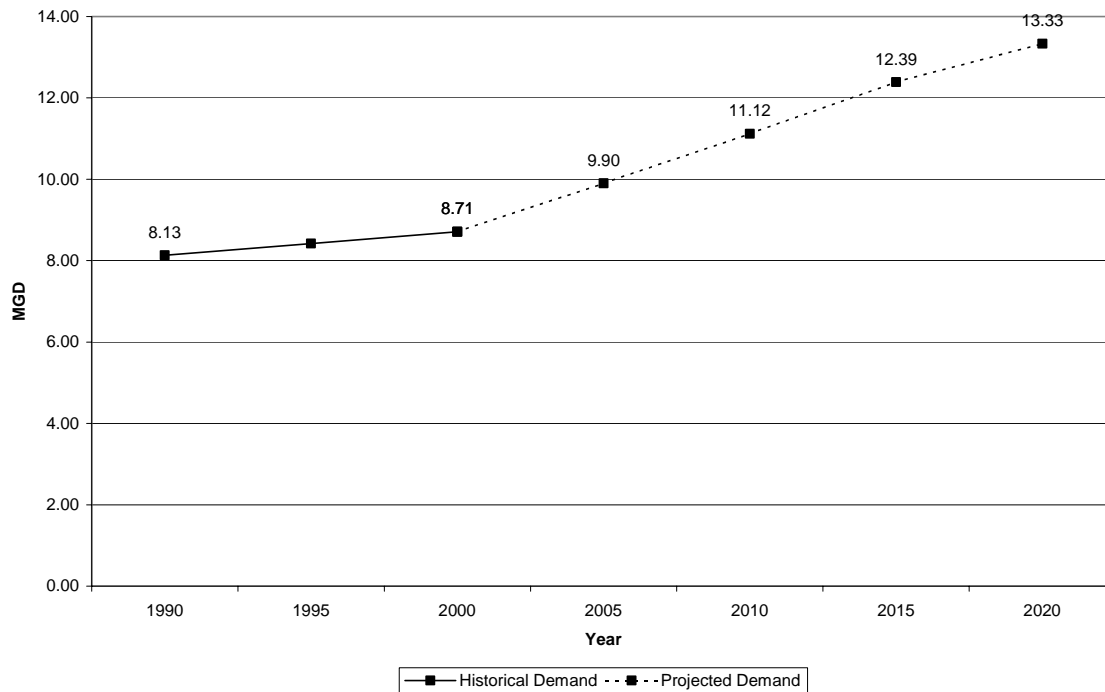
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WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	1990		2000		2005	Added Use (Mgd)	Total Use (Mgd)	2010	Added Use (Mgd)	Total Use (Mgd)	2015	Added Use (Mgd)	Total Use (Mgd)	2020	Added Use (Mgd)	Total Use (Mgd)
	Use (Mgd)	Ave. Use*	Use (Mgd)	Ave. Use*												
Wailuku-Kahului	3.44	469	4.24	477	1402	0.67	4.90	2722	1.30	5.53	4046	1.93	6.17	5387	2.57	6.81
Single-Family	0.57	337	0.81	337	350	0.12	0.93	681	0.23	1.04	1011	0.34	1.15	1347	0.45	1.26
Multi-Family	2.71	3126	1.92	3126	86	0.27	2.19	194	0.61	2.53	311	0.97	2.89	430	1.34	3.27
Comm./Industrial	0.09	206	0.05	206	28	0.01	0.06	55	0.01	0.06	104	0.02	0.07	154	0.03	0.08
Hotel	0.12	-	0.15	-	0.00	0.00	0.15	0.00	0.00	0.15	0.00	0.00	0.15	0.00	0.00	0.15
Agriculture	1.20	-	1.54	-	-	0.14	1.67	-	0.28	1.81	-	0.42	1.96	-	0.56	1.76
Govt./Religion	8.13		8.71			1.21	9.90		2.43	11.12		3.68	12.39		4.95	13.33

*Unit = gpd/unit

Wailuku-Kahului Water Demand Projection

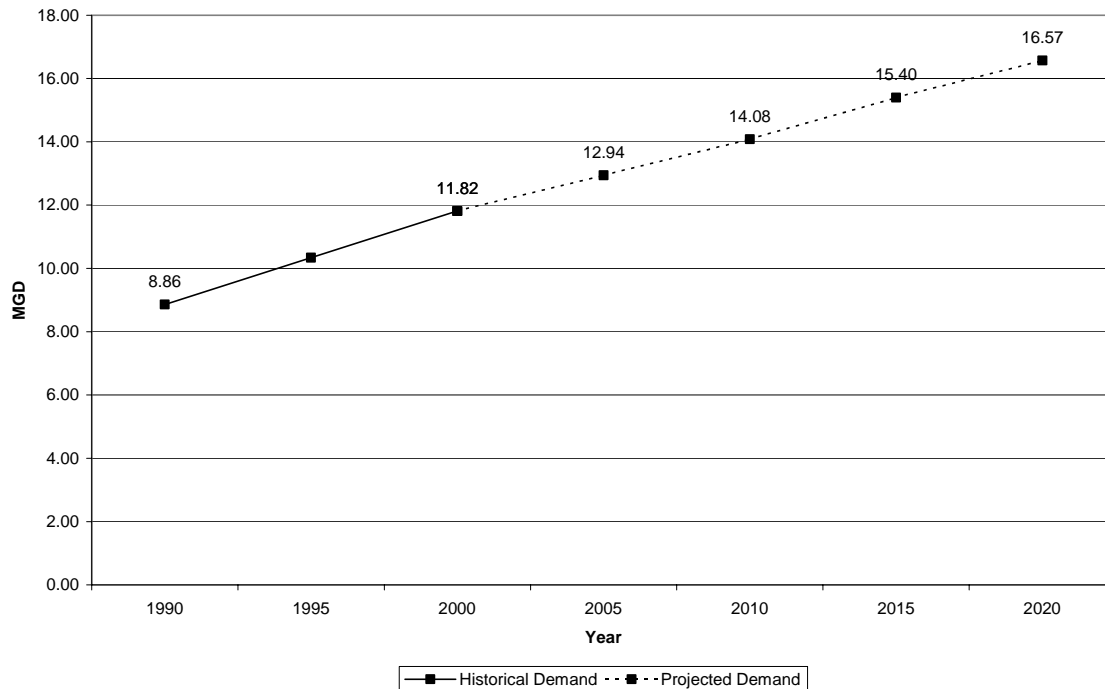


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WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	1990 Use (Mgd)	Ave. Use*	2000 Use (Mgd)	Ave. Use*	2005 Increase	Added Use (Mgd)	Total Use (Mgd)	2010 Increase	Added Use (Mgd)	Total Use (Mgd)	2015 Increase	Added Use (Mgd)	Total Use (Mgd)	2020 Increase	Added Use (Mgd)	Total Use (Mgd)
Kihei-Makena	2.99	983	3.87	947	559	0.53	4.40	1086	1.03	4.90	1614	1.53	5.40	2000	1.89	5.77
Single-Family	2.51	380	3.75	380	457	0.17	3.92	888	0.34	4.09	1320	0.50	4.25	1636	0.62	4.37
Multi-Family	1.80	7563	1.05	7563	21	0.16	1.21	50	0.38	1.43	80	0.61	1.65	111	0.84	1.89
Comm./Industrial	1.00	537	2.09	537	420	0.23	2.31	811	0.44	2.52	1540	0.83	2.91	2275	1.22	3.31
Hotel	0.29	-	0.61	-	0.00	0.00	0.61	0.00	0.00	0.61	0.00	0.00	0.61	0.00	0.00	0.61
Agriculture	0.27	-	0.45	-	-	0.04	0.49	-	0.09	0.53	-	0.13	0.58	-	0.17	0.62
Govt./Religion	8.86		11.82			1.13	12.94		2.28	14.08		3.60	15.40		4.74	16.57

*Unit = gpd/unit

Kihei-Makena Water Demand Projection

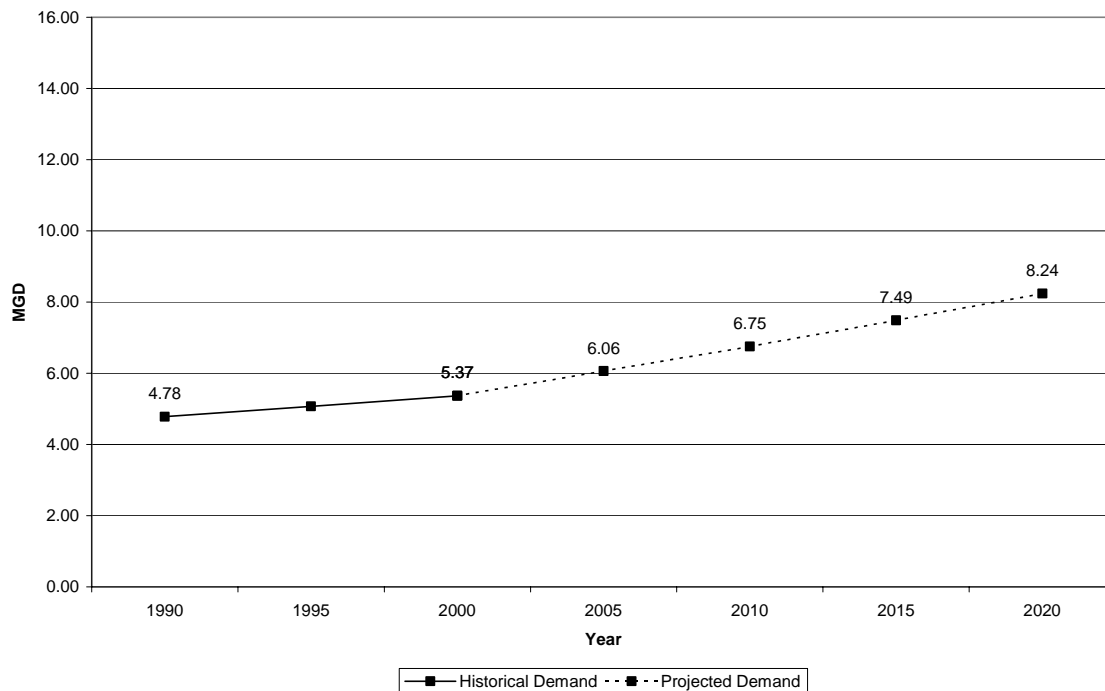


WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	1990 Use (Mgd)	Ave. Use*	2000 Use (Mgd)	Ave. Use*	2005 Increase	Added Use (Mgd)	Total Use (Mgd)	2010 Increase	Added Use (Mgd)	Total Use (Mgd)	2015 Increase	Added Use (Mgd)	Total Use (Mgd)	2020 Increase	Added Use (Mgd)	Total Use (Mgd)
West Maui																
Single-Family	1.45	650	1.65	701	562	0.39	2.05	1091	0.77	2.42	1622	1.14	2.79	2160	1.51	3.17
Multi-Family	1.35	428	1.74	428	101	0.04	1.78	196	0.08	1.82	291	0.12	1.86	387	0.17	1.90
Comm./Industrial	1.21	5127	0.77	5127	25	0.13	0.90	55	0.28	1.06	89	0.46	1.23	123	0.63	1.40
Hotel	0.50	400	0.48	400	138	0.06	0.54	265	0.11	0.59	504	0.20	0.69	744	0.30	0.78
Agriculture	0.00	-	0.04	-	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04
Govt./Religion	0.27	-	0.69	-	-	0.06	0.75	-	0.13	0.82	-	0.19	0.88	-	0.26	0.95
	4.78		5.37			0.68	6.06		1.37	6.75		2.11	7.49		2.87	8.24

*Unit = gpd/unit

West Maui Water Demand Projection



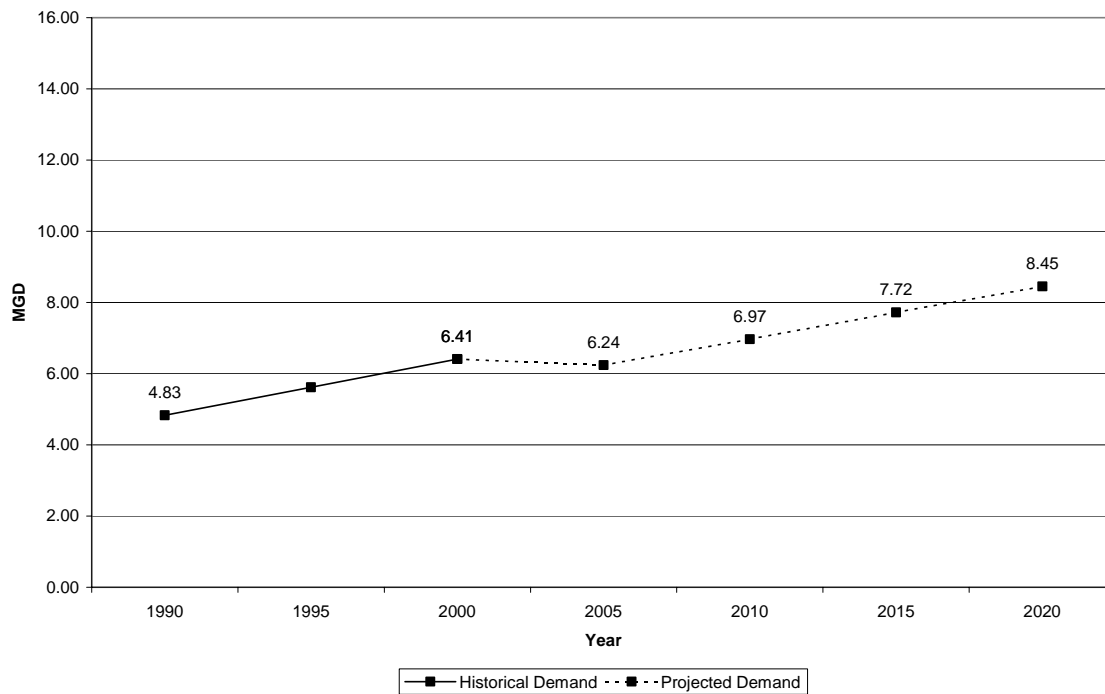
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WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	1990 Use (Mgd)	Ave. Use*	2000 Use (Mgd)	Ave. Use*	2005 Increase	Added Use (Mgd)	Total Use (Mgd)	2010 Increase	Added Use (Mgd)	Total Use (Mgd)	2015 Increase	Added Use (Mgd)	Total Use (Mgd)	2020 Increase	Added Use (Mgd)	Total Use (Mgd)
Makawao-Kula	2.15	417	2.61	474	812	0.39	3.00	1577	0.75	3.36	2344	1.11	3.72	3121	1.48	4.09
Single-Family	0.01	223	0.07	223	43	0.01	0.08	83	0.02	0.09	123	0.03	0.10	164	0.04	0.10
Multi-Family	0.21	5122	0.17	5122	8	0.04	0.21	20	0.10	0.27	32	0.16	0.33	44	0.23	0.39
Comm./Industrial	0.01	400	0.01	400	4	0.00	0.01	7	0.00	0.01	14	0.01	0.02	20	0.01	0.02
Hotel	2.41	-	3.32	-	0.00	0.28	2.69	0.00	0.56	2.97	0.00	0.85	3.26	0.00	1.13	3.54
Agriculture	0.04	-	0.23	-	-	0.02	0.25	-	0.04	0.27	-	0.06	0.29	-	0.08	0.31
Govt./Religion	4.83		6.41			0.74	6.24		1.47	6.97		2.22	7.72		2.97	8.45

*Unit = gpd/unit

Makawao-Kula Water Demand Projection

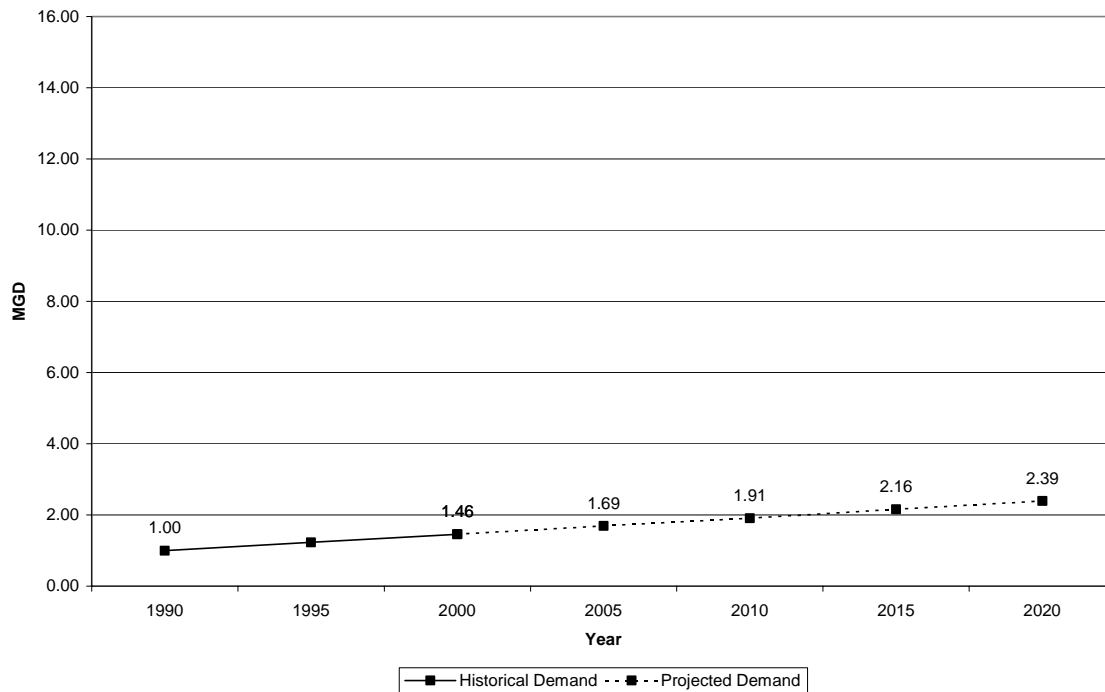


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WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	2000 Use (Mgd)	Ave. Use*	2005 Increase	Added Use (Mgd)	Total Use (Mgd)	2010 Increase	Added Use (Mgd)	Total Use (Mgd)	2015 Increase	Added Use (Mgd)	Total Use (Mgd)	2020 Increase	Added Use (Mgd)	Total Use (Mgd)
Paia-Haiku	1.11	410	419	0.17	1.28	814	0.33	1.44	1210	0.50	1.61	1611	0.66	1.77
Single-Family	0.04	560	22	0.01	0.06	43	0.02	0.07	64	0.04	0.08	85	0.05	0.09
Multi-Family	0.08	6000	6	0.04	0.12	15	0.09	0.17	24	0.14	0.23	33	0.20	0.28
Comm./Industrial	0.00	350	4	0.00	0.00	7	0.00	0.00	14	0.00	0.00	20	0.01	0.01
Hotel	0.19	-	0.00	0.00	0.19	0.00	0.00	0.19	0.00	0.00	0.19	0.00	0.00	0.19
Agriculture	0.04	-	-	0.00	0.04	-	0.01	0.04	-	0.01	0.05	-	0.01	0.05
Govt./Religion	1.46			0.22	1.69		0.45	1.91		0.69	2.16		0.93	2.39

*Unit = gpd/unit

Paia-Haiku Water Demand Projection



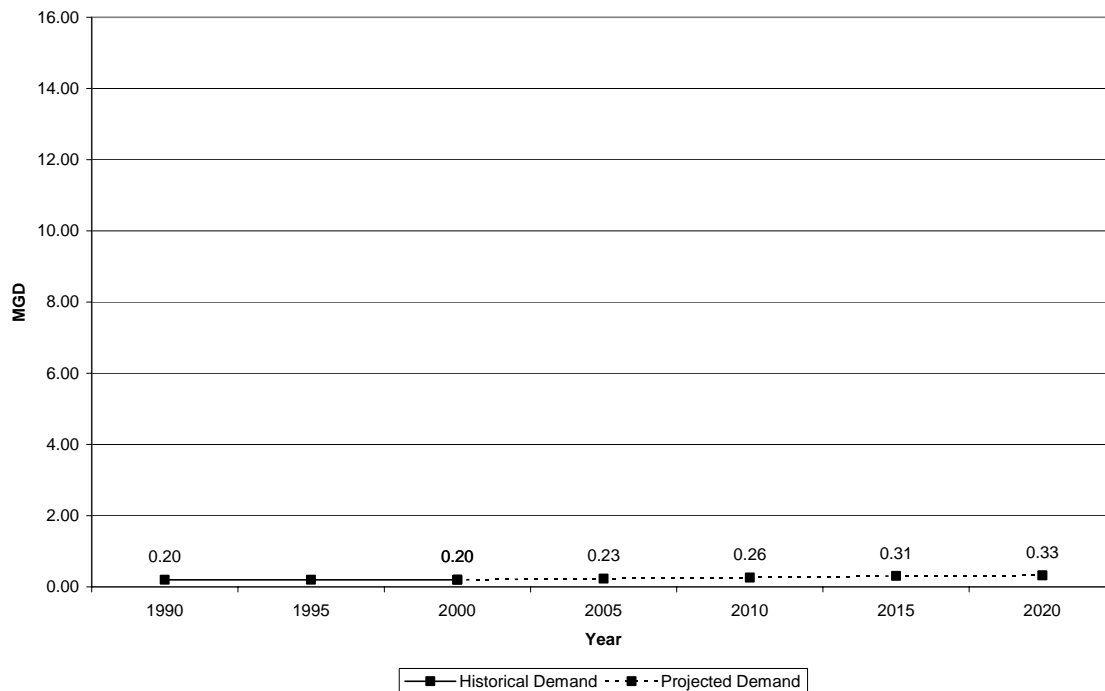
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WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	2000 Use (Mgd)	Ave. Use*	2005 Increase	Added Use (Mgd)	Total Use (Mgd)	2010 Increase	Added Use (Mgd)	Total Use (Mgd)	2015 Increase	Added Use (Mgd)	Total Use (Mgd)	2020 Increase	Added Use (Mgd)	Total Use (Mgd)
Hana	0.13	336	66.00	0.02	0.15	126	0.04	0.17	188	0.06	0.20	251	0.08	0.22
Single-Family	0.00	560	3.00	0.00	0.00	7	0.00	0.00	10	0.01	0.01	13	0.01	0.01
Multi-Family	0.01	6000	1.00	0.01	0.02	2	0.01	0.02	4	0.02	0.03	4	0.02	0.03
Comm./Industrial	0.01	350	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
Hotel	0.01	-	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
Agriculture	0.04	-	-	0.00	0.04	-	0.01	0.05	-	0.01	0.05	-	0.01	0.05
Govt./Religion	0.20			0.03	0.23		0.06	0.26		0.10	0.31		0.12	0.33

*Unit = gpd/unit

Hana Water Demand Projection



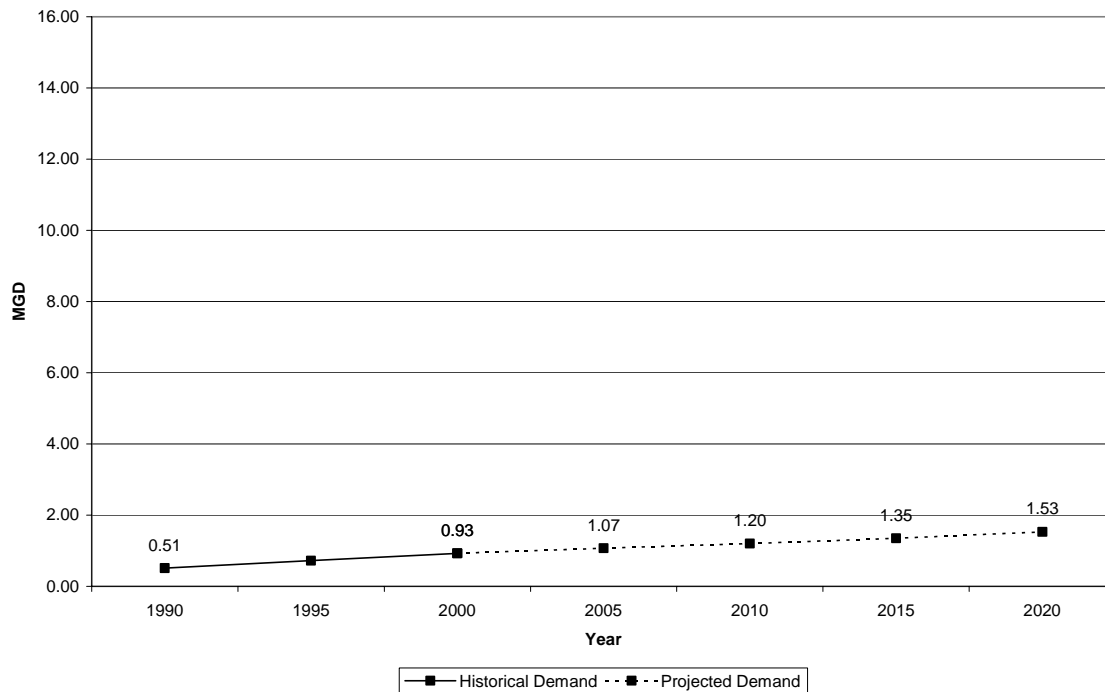
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WATER DEMAND PROJECTIONS, 1990 TO 2020, BY LAND USE

	2000 Use (Mgd)	Ave. Use*	2005 Increase	Added Use (Mgd)	Total Use (Mgd)	2010 Increase	Added Use (Mgd)	Total Use (Mgd)	2015 Increase	Added Use (Mgd)	Total Use (Mgd)	2020 Increase	Added Use (Mgd)	Total Use (Mgd)
Molokai	0.62	495	171	0.08	0.71	326	0.16	0.78	505	0.25	0.87	698	0.35	0.97
Single-Family	0.04	560	16	0.01	0.05	30	0.02	0.06	47	0.03	0.07	65	0.04	0.08
Multi-Family	0.08	6000	6	0.04	0.11	12	0.07	0.15	19	0.11	0.19	27	0.16	0.24
Comm./Industrial	0.04	350	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00	0.04
Hotel	0.03	-	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03
Agriculture	0.12	-	-	0.01	0.13	-	0.02	0.14	-	0.04	0.15	-	0.05	0.17
Govt./Religion	0.93			0.14	1.07		0.27	1.20		0.43	1.35		0.60	1.53

*Unit = gpd/unit

Molokai Water Demand Projection



***County of Maui
Infrastructure Assessment Update***

Wastewater Systems

Prepared for:

***County of Maui
Planning Department***

Prepared by:

Wilson Okamoto & Associates, Inc.

May 2003

TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	
I. INTRODUCTION	1
II. ASSESSMENT METHODOLOGY	2
A. Wastewater Flow Projections	2
1. Visitor Population Wastewater Flows	2
2. Resident Population Wastewater Flows.....	3
3. Projections.....	4
III. WAILUKU-KAHULUI WASTEWATER SYSTEM	6
A. Existing System/Service Area	6
1. Tributary Service Area Characteristics	6
2. Existing System Characteristics.....	7
B. Assessment of Existing System Problems, Limitations and Opportunities	8
1. Collection System	8
2. Treatment Facility	10
3. Wastewater Reclamation	10
C. Assessment of Future System Requirements	11
IV. LAHAINA WASTEWATER SYSTEM.....	13
A. Existing System/Service Area	13
1. Tributary Service Area Characteristics	13
2. Existing System Characteristics.....	13
B. Assessment of Existing System Problems, Limitations and Opportunities	14
1. Collection System	14
2. Treatment Facility	15
C. Assessment of Future System Requirements	16
V. KIHAI DISTRICT WASTEWATER SYSTEM.....	18
A. Existing System/Service Area	18
1. Tributary Service Area Characteristics	18
2. Existing System Characteristics.....	19
B. Assessment of Existing System Problems, Limitations and Opportunities	20
1. Collection System	20
2. Treatment Facility	21
C. Assessment of Future System Requirements	21

VI.	MAKAWAO-PUKALANI-KULA DISTRICT WASTEWATER SYSTEM.....	24
	A. Existing System/Service Area	24
	1. Tributary Service Area Characteristics	24
	2. Existing System Characteristics.....	24
	B. Assessment of Existing System Problems, Limitations and Opportunities	24
	1. Collection System	24
	C. Assessment of Future System Requirements	25
VII.	MOLOKAI WASTEWATER SYSTEM.....	26
	A. Existing System Service Area	26
	1. Tributary Service Area Characteristics	26
	2. Existing System Characteristics.....	26
	B. Assessment of Existing System Problems, Limitations and Opportunities	27
	1. Collection System	27
	2. Treatment Facility	28
	C. Assessment of Future System Requirements	28
VIII.	LANAI WASTEWATER SYSTEM	31
	A. Existing System Service Area	31
	1. Existing System Characteristics.....	31
	B. Assessment of Existing System Problems, Limitations and Opportunities	31
	1. Collection System	31
	2. Treatment Facility	32
	C. Assessment of Future System Requirements	33

TABLE OF CONTENTS (Continued)**LIST OF CHARTS**

	<u>Page</u>
CHART 1 Wailuku-Kahului WWRF Flow Projections	12
CHART 2 Lahaina WWRF Flow Projections	17
CHART 3 Kihei WWRF Flow Projections	23
CHART 4 Kaunakakai WWRF Flow Projections	30
CHART 5 Lanai WWRF Flow Projections	34

LIST OF TABLES

	<u>Page</u>
TABLE 1 Historical and Projected Wastewater Flows	2
TABLE 2 Average Daily Visitor Wastewater Flows, 1990 & 2000	3
TABLE 3 Resident Population Wastewater Flows, 1990 & 2000	4
TABLE 4 Wastewater Flow Projections	5
TABLE 5 Wailuku-Kahului Wastewater Reclamation Facility Plant Capacity Status, December 31, 2001	8
TABLE 6 Wailuku-Kahului Wastewater Reclamation Facility Projected Wastewater Flows	11
TABLE 7 Lahaina Wastewater Reclamation Facility Projected Wastewater Flows	16
TABLE 8 Kihei Wastewater Reclamation Facility Plant Capacity Status, Decmeber 31, 2001	20
TABLE 9 Kihei Wastewater Reclamation Facility Projected Wastewater Flows	22
TABLE 10 Kaunakakai Wastewater Reclamation Facility Projected Wastewater Flows	29
TABLE 11 Lanai Wastewater Reclamation Facility Projected Wastewater Flows	33

EXECUTIVE SUMMARY

A. Introduction

The Wastewater Systems section of the County of Maui Infrastructure Assessment Update provides an assessment of the existing wastewater collection, treatment and disposal systems of the major County owned and operated wastewater systems. The wastewater systems that were assessed include the Wailuku-Kahului System, Kihei-Makena System, Lahaina-Napili System, Lanai City System, Kaunakakai System, Kualapuu System, and Haliimaile System. The overall objective of the assessment was to determine required upgrades for the County wastewater systems and to assess whether the systems will experience capacity constraints based on the population and visitor forecasts provided in the *Maui Community Plan Update Program: Socio-Economic Forecast*.

B. Assessment Methodology

Wastewater flows for each of the five county Wastewater Reclamation Facilities (WWRFs) were projected based on population and visitor. Wastewater flow projections were separated by visitor wastewater flows and resident wastewater flows. To project visitor wastewater flows, a wastewater generation rate of 155.56 gallons per visitor day was used as recommended by the County's Wastewater Reclamation Division Policy/Guideline for Standards of Wastewater Contribution. To project resident wastewater flows, historical wastewater flows were used to derive a per capita flow rate for each County Wastewater Reclamation Facility (WWRF). Historical and projected wastewater flows for each WWRF are provided in Table 1.

C. Wastewater Systems

1. Wailuku-Kahului Wastewater System

The Wailuku-Kahului WWRF serves the communities of Kahului, Wailuku, Paia, Kuau, and Spreckelsville and generally corresponds to the Wailuku-Kahului Community Planning District. The Wailuku-Kahului WWRF has a design capacity of 7.9 mgd average dry-weather flow (ADWF), of which 6.958 mgd or 88 percent of its rated ADWF capacity has been allocated. In 2000, flows to the Wailuku-Kahului WWRF averaged 5.34 mgd. Wastewater from the Wailuku-Kahului WWRF is presently disposed of by eight gravity injection wells. The feasibility of using reclaimed water from the Wailuku-Kahului WWRF has thus far been economically unfeasible, but may become viable if recent changes in irrigation practices affect the sustainable yield of the basal aquifers underlying the Wailuku-Kahului region.

TABLE 1
HISTORICAL AND PROJECTED WASTEWATER FLOWS

Facility	Existing Capacity (mgd)	Historical and Projected Flows (mgd)					
		1991	2000	2005	2010	2015	2020
Wailuku-Kahului	7.9	5.06	5.34	6.43	6.97	7.51	8.05
Lahaina	9.0	4.37	5.31	5.84	6.32	6.83	7.35
Kihei	8.0	3.20	4.65	5.42	5.87	6.32	6.80
Kaunakakai	0.3	0.34	0.20	0.26	0.32	0.39	0.46
Lanai	0.5	0.19	0.31	0.33	0.36	0.40	0.43

The Wailuku-Kahului wastewater collection system is the largest and oldest of Maui County's collection system regions. The Wailuku-Kahului collection system consists of 15 County owned and operated pumping stations, about 100 miles of gravity sewers, and 10 miles of force main. Among the recommendations for the Wailuku-Kahului collection system are performing closed-circuit television (CCTV) inspections on sewers with a high critical sewer rating in the next two years and on medium priority sewers over the next five years. There are approximately 37,000 lineal feet of sewers with a high priority rating and an additional 39,000 lineal feet of sewers with a medium priority rating. In addition, accelerated/enhanced preventative maintenance should be performed on the 32,000 lineal feet of low-priority sewers in the Wailuku-Kahului collection system.

In 2000, the Wailuku-Kahului Community Planning District had a resident population of 41,503 and an average daily visitor census of 1,180. By 2020, the Wailuku-Kahului region is projected to have a population of 56,626 and an average daily visitor census of 1,547. Based on the projections, and assuming that all new developments are connected to the County sewer system, the Wailuku-Kahului WWRF is expected to be at its design capacity of 7.9 mgd sometime between 2015 and 2020. There are presently no plans to expand the capacity of the Wailuku-Kahului WWRF, although the County has a FY 2003 capital improvement project planned to study the feasibility of constructing a new Central Maui WWRF. If determined to be feasible, the Central Maui WWRF would replace the Wailuku-Kahului WWRF as well as provide the capability for future expansion.

2. Lahaina Wastewater System

The Lahaina WWRF serves the West Maui region from Puamana to Kapalua and generally corresponds to the West Maui Community Planning District. The Lahaina WWRF, which is actually two separate wastewater reclamation facilities on one site, has a design capacity of 9.0 mgd ADWF. Presently, 6.138 mgd or 92 percent of the facility's ADWF capacity has been allocated. In 2000, flows to the Lahaina WWRF averaged 5.31 mgd. Reclaimed water from the Lahaina WWRF is used by the Kaanapali Resort for golf course and roadway landscape irrigation and at the Lahaina WWRF. The Lahaina WWRF also has a fill station that allows contractors to fill water wagons for dust control purposes. The remainder of the effluent is disposed of by gravity injection wells.

The Lahaina collection system consists of 16 County owned and operated pumping stations, 74,670 feet of gravity sewer, and 10,700 feet of force main. Among the recommendations for the Lahaina collection system are to perform CCTV inspections on approximately 32,000 lineal feet of sewers with a high priority rating in the next two years and 14,000 lineal feet of sewers with a medium priority rating in the next five years. The majority of high priority sewer lines are located in the central Lahaina town area, in the Kaanapali beach resort area, or along Honoapiilani Highway from Kaanapali up to Napili. These sewers were given high priority ratings due to potential consequences, rather than risk of failure. The medium priority sewers are scattered throughout the system, but tend to be located close to the coastline.

In 2000, the West Maui Community Planning District had a population of 17,967 and an average daily visitor census of 23,356. By 2020, the West Maui community planning district is projected to have a resident population of 24,741 and an average daily visitor census of 31,438. Based on these projections, and assuming that all new developments are connected to the County sewer system, the Lahaina WWRf is expected to have sufficient capacity beyond 2020.

3. Kihei Wastewater System

The Kihei WWRf serves the communities of Kihei, Wailea and Makena and generally corresponds to the Kihei-Makena Community Planning District. The Kihei WWRf has a design capacity of 8.0 mgd ADWF of which 5.937 mgd has been allocated. In 2000, flows to the Kihei WWRf averaged 4.65 mgd. Reclaimed water from the Kihei WWRf is used for irrigation purposes by numerous water users in the Kihei area. Unused reclaimed water is disposed of by three gravity injection wells.

The Kihei collection system consists of 10 County owned and operated pumping stations, 40 miles of gravity sewer, and 6 miles feet of force main. Among the recommendations for the Kihei collection system are to perform CCTV inspections on approximately 17,000 lineal feet of sewers with a high priority rating in the next two years and 7,000 lineal feet of sewers with a medium priority rating in the next five years. Accelerated/enhanced maintenance should be performed on 13,000 lineal feet of low priority sewers.

In 2000, the Kihei-Makena Community Planning District had a population of 22,870 and an average daily visitor census of 16,669. By 2020, the Kihei-Makena community planning district is projected to have a resident population of 31,642 and an average daily visitor census of 22,106. Based on these projections, it appears that the Kihei WWRf will have sufficient capacity through year 2020.

4. Makawao-Pukalani-Kula District

The majority of the Makawao-Pukalani-Kula Community Planning District is not served by County wastewater facilities. Only the Haliimaile subdivision is served by County wastewater facilities and a portion of the Pukalani area is served by a private wastewater

treatment facility. Cesspools and septic tanks serve the remainder of the area. It is anticipated that wastewater from new developments will be accommodated through individual wastewater systems.

5. Island of Molokai

Wastewater service on the island of Molokai is provided by the County of Maui in the town of Kaunakakai and the Kualapuu subdivision. Wastewater collected from the Kaunakakai system is conveyed to the Kaunakakai WWRF for treatment while wastewater from the Kualapuu subdivision is conveyed to a private wastewater treatment facility owned and operated by Molokai Ranch. The Kaunakakai WWRF has a design capacity of 0.3 mgd of which 0.289 mgd has been allocated. The Kaunakakai WWRF exceeded its design capacity in 1991, 1992 and 1993 but flows to the facility decreased substantially in the mid- to late-1990's, which may be partially attributed to a County program to install water conserving fixtures in residences on Molokai. Reclaimed water from the Kaunakakai WWRF is used for irrigation purposes or disposed of via injection wells.

The Kaunakakai collection system consists of 1 County owned and operated pump station, 8 miles of gravity sewers, and about 0.2 miles of force main. Information regarding the Kualapuu collection system is not available. Among the recommendations for the Molokai collection system are to perform CCTV inspections on approximately 928 lineal feet of sewers with a high priority rating in the next two years and 1,200 lineal feet of sewers with a medium priority rating in the next five years. Accelerated/enhanced maintenance should be performed on 4,600 lineal feet of low priority sewers.

In 2000 the island of Molokai had a resident population of 7,404 and an average daily visitor census of 905. Based on census tract population data, it is estimated that in 2000 the resident population served by the Kaunakakai WWRF was about 2,500. The resident population in the Kaunakakai area is expected to increase to 5,690 by 2020. In calculating projected flows to the Kaunakakai WWRF, wastewater flows attributable to visitors were not included since the majority of visitor units on Molokai are not connected to the Kaunakakai WWRF. Based on the projected wastewater flows, the Kaunakakai WWRF is anticipated to be at its design capacity of 0.3 mgd between 2005 and 2010. According to County Wastewater Reclamation Division personnel, however, flows to the Kaunakakai WWRF are not expected to increase significantly in the future since the development potential within the Kaunakakai WWRF service area is limited. The County plans to initiate a facility plan study when the average dry weather flow of the Kaunakakai WWRF reaches 75% of the facility's design flow.

6. Island of Lanai

The Lanai WWRF serves the resort, business and residential population of the Lanai City area. The Lanai WWRF has a design capacity of 0.5 mgd of which 0.325 mgd has been allocated.

The Lanai collection system consists of 11 miles of gravity sewers with no County owned pump stations or force mains. Since the Lanai wastewater system is small and relatively new, nearly 97 percent of the collection system is rated as non-problem areas. Among the recommendations for the Lanai collection system are to perform CCTV inspection on approximately 461 lineal feet of medium priority sewers over the next five years. Accelerated/enhanced preventative maintenance should also be performed on approximately 1,152 lineal feet of low priority sewers.

In 2000, the island of Lanai had a resident population of 3,193 and an average daily visitor census of 1,131. Based on census tract population data, it is estimated that in 2000 the resident population served by the Lanai WWRF was about 3,170. The resident population of the Lanai City area is expected to increase to 4,442 by 2020. In calculating projected flows to the Lanai WWRF, wastewater flows attributable to visitors were not included since the majority of visitor units on Lanai are not connected to the Lanai WWRF. Based on the projected wastewater flows, the Lanai WWRF is expected to have adequate capacity through 2020.

I. INTRODUCTION

This section presents an assessment of the existing wastewater collection, treatment and disposal systems as well as future plans and requirements for wastewater systems within the County of Maui. Specifically, the study provides an overview of the existing wastewater systems on the islands of Maui, Molokai and Lanai and identifies capacity constraints based on population projections provided by the *Maui Community Plan Update Program: Socio-Economic Forecast*.

The findings herein are not meant to represent a master plan for wastewater system development. The intent is to focus on the demand-related constraints and improvements that may need to be considered in the course of revising the existing community plans. Existing studies, including system master plans, have much more in-depth analysis of each wastewater system and further studies of such depth will be required to assess system deficiencies and provide specific recommendations for system improvements.

The recommendations provided in this study are based directly on the population projections that have been developed for the Community Plan Update Program. These projections may differ from projections in other infrastructure plans.

II. ASSESSMENT METHODOLOGY

The assessment of the County's wastewater system is generally organized by wastewater system regions, rather than community plan districts. On the Island of Maui, there are three major wastewater systems including the Wailuku-Kahului System, Kihei-Makena System, and Lahaina-Napili System. These systems generally correspond to the community planning districts of Wailuku-Kahului, Kihei-Makena, and West Maui. A county owned and maintained collection system also serves the Haliimaile subdivision. The Haliimaile subdivision system discharges into a private wastewater pond owned by Maui Land and Pineapple Company.

The island of Lanai has one wastewater reclamation facility located in central Lanai that serves Lanai City. The island of Molokai has two wastewater systems, one that serves the main town of Kaunakakai and a second that serves the community of Kualapuu. The county maintains the collection system for the Kualapuu community but the wastewater processing plant is privately owned.

The assessment of each wastewater system summarizes collection, treatment and disposal facilities, current demand on those facilities, significant problems and limitations, and projected demands. Studies completed since the preparation of the 1992 Infrastructure Assessment and discussions with County personnel provided the foundation for this study. In particular, the *Preliminary Wastewater System Analysis and Planning, Phase I* prepared for DPWWM by Fukunaga. & Associates, Inc. and Brown and Caldwell was used to update the existing collection systems. Discussions with County staff and information obtained were used to update the information for each of the wastewater treatment facilities. Each of the wastewater systems were reviewed in conjunction with the population projections prepared for the Community Plan Update Program to project future wastewater demands and required improvements.

A. Wastewater Flow Projections

1. Visitor Population Wastewater Flows

Wastewater flows were projected by developing flow rates for resident and visitor populations. For the island of Maui, the average daily visitor census for each treatment facility service area was taken from the *Maui Community Plan Update Program: Socio-Economic Forecast, Phase I Report, Pre-final version* (SMS, May 29, 2002). The Socio-Economic Forecast report provides historical (1990) and projected (to 2020) population counts of resident and visitor population by Community Plan region. As recommended by the County's Wastewater Reclamation Division's Policy/Guideline for Standards of Wastewater Contribution dated February 4, 1991, the daily wastewater contribution of a resort hotel room with laundry service is 350 gallons per unit per day. Based on a hotel occupancy of 2.25 persons per room, a flow rate of 155.56 gallons per visitor per day was used to determine the visitor population's portion of total wastewater flows to each treatment facility. Visitor populations for the islands of Molokai and Lanai

TABLE 2
AVERAGE DAILY VISITOR WASTEWATER FLOWS,
1990 & 2000

Treatment Facility	Flow Rate (gpd/person)	Average Daily Visitor Census (1990)	Average Daily Visitor Census (2000)	Visitor Flows 1990 (mgd)	Visitor Flows 2000 (mgd)
Wailuku – Kahului	155.56	1,294	1,180	201,295	183,561
Lahaina	155.56	20,401	23,356	3,173,580	3,633,259
Kihei	155.56	15,404	15,994	2,396,246	2,488,027
Kaunakakai	155.56	--	--	--	--
Lanai	155.56	--	--	--	--

were excluded because the majority of resorts on these islands are not connected to the public sewer system. Table 2 shows the flows to each wastewater treatment facility in 1990 and 2000 attributed to visitors based on the average daily visitor census figures provided by the Socio-Economic Forecast Report.

2. Resident Population Wastewater Flows

Historical wastewater flows processed at each wastewater reclamation facility for 1991 to 2001 were provided by the County Wastewater Reclamation Division. In developing historical flow rates for 1990, it was assumed that flows between 1990 and 1991 had not changed significantly and therefore the 1991 wastewater flow figures were used. The exception to this method is that 1990 flows for the Wailuku-Kahului WWRF were taken from the *Kahului Wastewater Treatment Facility Expansion Study* (Brown and Caldwell, 1989) because 1991 flows to the Wailuku-Kahului WWRF appeared unusually low. By subtracting the visitor population's portion of wastewater flows from the total wastewater flows received at each facility, the total flow attributable to the resident population was calculated. The resident population served by each wastewater reclamation facility was derived by using Arcview GIS to overlay existing sewerlines over 1990 and 2000 census blocks. The total resident population flows were divided by the "sewered" resident population to derive a per capita flow rate for each treatment facility. Table 3 shows the resident population share of total flows received at each wastewater reclamation facility for 1990 and 2000.

TABLE 3
RESIDENT POPULATION WASTEWATER FLOWS, 1990 & 2000

Facility	Resident Flow 1990 (Actually 1991) (GPD)	Resident Sewered Population 1990	Resident Per Capita Flow 1990 (GPD)	Resident Flow 2000 (GPD)	Resident Sewered Population 2000	Resident Per Capita Flow 2000 (GPD)	Avg. 1990 & 2000 Per Capita Flow (GPD)
Wailuku-Kahului	4,859,711	31,364	154.9	5,157,444	43,285	119.2	137.0
Lahaina	1,193,511	13,050	91.5	1,680,844	16,875	99.6	95.5
Kihei	803,822	12,643	63.6	2,166,044	20,417	106.1	84.8
Kaunakakai	340,000	1,861	182.7	200,000	2490	80.3	131.5
Lanai	191,000	2,400	79.6	309,000	3169	97.5	88.5

For projection purposes, the more conservative resident per capita flow was used, except for the Wailuku-Kahului WWRF where the average of the 1990 and 2000 per capita flows was used and the Kaunakakai WWRF, where the 2000 flow rate was used.

The per capita flows for the Kaunakakai WWRF and Wailuku-Kahului WWRF are on opposite ends of the “average” flow rates. This may partially be due to different infiltration and inflow (I/I) contributions. The I/I is included in the “total” flow figures provided by the County, but are not computed or quantified. Also, for the Kaunakakai WWRF, the County instituted a program for installing water conserving fixtures in residences in the 1990’s, which partially explains the decline in flows between 1990 and 2000.

3. Projections

The resident and visitor per capita flow rates were used in conjunction with the median (baseline) population projections from the Socio-Economic Forecast report to project wastewater flows for each wastewater reclamation facility to 2020. All population growth was assumed to occur within the sewered regions of each wastewater service area to be conservative. Results of the analysis are provided in Table 4.

TABLE 4
WASTEWATER FLOW PROJECTIONS

FACILITY	Year/Wastewater Flows (mgd)			
	2005	2010	2015	2020
Wailuku-Kahului WWRf	6.43	6.97	7.51	8.05
Lahaina WWRf	5.84	6.32	6.83	7.35
Kihei WWRf	5.42	5.87	6.32	6.8
Kaunakakai WWRf	0.26	0.32	0.39	0.46
Lanai WWRf	0.33	0.36	0.40	0.43

Based on the projections, the Lahaina (9.0 mgd capacity), Kihei (8.0 mgd capacity) and Lanai (0.5 mgd capacity) Wastewater Reclamation Facilities are not expected to reach capacity until after 2020. The Wailuku Wastewater Reclamation Facility, on the other hand, is expected to be at capacity (7.9 mgd) sometime after 2015. Based on historical flows, the Kaunakakai Wastewater Reclamation Facility exceeded the Facility's design capacity of 0.3 mgd in 1991, 1992, and 1993, and is projected to be at capacity once again after 2005.

The region of most concern is Molokai, which has already exceeded capacity in the past and is expected to once again after 2005. Although the historical records reveal a decline in wastewater flow on Molokai, the population projections point towards a reversal in that downward trend. According to Wastewater Reclamation personnel, however, the potential for future development within the sewered area is limited and they do not foresee any major developments within the sewered area that would significantly impact the Kaunakakai WWRf. The wastewater reclamation facilities in the other regions should stay under capacity through 2020, with the exception of the Wailuku-Kahului WWRf which is expected to exceed capacity after 2015.

III. WAILUKU-KAHULUI WASTEWATER SYSTEM

A. Existing System/Service Area

1. Tributary Service Area Characteristics

The Wailuku-Kahului Wastewater Reclamation Facility is owned and operated by the County of Maui and serves the communities of Kahului, Wailuku, Paia, Kuau, and Spreckelsville. Of these areas, Paia and Kuau are located outside of the Wailuku-Kahului Community District and within the Paia-Haiku Community District.

Sewage flow contributions from different parts of the Wailuku-Kahului collection system vary and are dependent upon the type and density of land use. For reference, the Wailuku-Kahului service area has been divided into four districts: Wailuku-Kahului, Waihee, Spreckelsville-Paia-Kuau, and Wailuku Heights-Waikapu.

a. Wailuku-Kahului

The Wailuku-Kahului district is the commercial, finance, governmental, and industrial center for the County. Major residential areas are located in both Kahului and Wailuku as well as in Paukalo and Waiehu, on the makai side of Wailuku.

Wailuku has a light industrial area on East Main Street while Baldwin High School, Maui Community College, Keolu Park and the Maui War Memorial Center are located on the eastern portion of the town.

Kahului was developed after Wailuku and has more distinct residential, business, and industrial areas. In addition to single-family residences in the western portion, there are several shopping centers and hotels located along Kaahumanu Avenue. A large commercial and industrial area is located on the west side of Hana Highway, and another industrial area is located north of South Wakea Avenue.

Kahului Airport and Kahului Harbor are major industrial areas. The airport in particular has experienced significant development in recent years. A small residential subdivision near the airport in the Kanaha Beach area is not connected to the sewer system. Some of the facilities at Kahului Harbor are also unsewered.

According to the *Maui Community Plan Update Program: Socio-Economic Forecast*, in 2000 the Wailuku-Kahului Planning District had a resident population of 41,503 and an average daily visitor census of 1,180. This represents an increase of 26% and decline of 9%, respectively, from 1990 population figures.

b. Waihee-Wailuku Heights-Waikapu

Waihee is located north of the Wailuku-Kahului area. It is a “Country Store” type of town consisting of a minor residential area surrounded by agricultural lands and the Waiehu Municipal Golf Course. The Waihee area is presently unsewered.

Wailuku Heights and Waikapu are located southwest of Wailuku. Wailuku Heights includes an older residential section as well as new and expanding residential areas to the south and east. Waikapu has a commercial zone and community center located along Honoapiilani Highway and expanding residential areas mauka of Honoapiilani Highway.

According to the 2000 census, the resident population of the Waihee-Waikapu census tract was 3,397. This represents an increase of about 49% from the population of 2,273 reported in the 1990 census.

c. Spreckelsville-Paia-Kuau

Spreckelsville, Paia, and Kuau are located along the Hana Highway south of Kahului. Although all of these communities are served by the Kahului Wastewater Reclamation Facility, only Spreckelsville lies within the Wailuku-Kahului Community District. Skill Village is regarded as an extension of Paia and is located several miles inland along Baldwin Avenue. These communities are predominately residential with a small commercial hub in Paia.

According to the 2000 census, the resident population of the Spreckelsville-Paia census tracts was 2,852. This represents an increase of about 24% from the population of 2,306 reported in the 1990 census.

2. Existing System Characteristics**a. Collection System**

The Wailuku-Kahului collection system is comprised of a network of gravity collection lines and force mains with 15 County owned and operated pump stations. The main collection route runs along a “spine” following the coast. To the west of the Wailuku-Kahului Wastewater Reclamation Facility, the line begins in Waiehu and is aligned with Waiehu Beach Road with four pump stations. A major pump station, the Wailuku WWPS, is located near the intersection of the Waiehu and Wailuku sewer systems along Kahului Beach Road. In addition to flows from Waiehu and Wailuku, the WWPS receives flows from Paukakalo, Wailuku Heights and the southwestern portion of Kahului. Skirting the edge of Kahului Harbor, the line then aligns itself with Kaahumanu Avenue. Along this alignment, flows from the northeastern part of Kahului are received. To the east of the WWRF, the main line begins at Kuau and is aligned with Hana Highway. Flows are collected from Kuau, Paia, Skill Village and Spreckelsville. At the airport, the line skirts around its makai side and follows Alahao Street into the WWRF.

The vast majority of sewer lines in the Wailuku-Kahului region are 8-inch diameter pipes constructed of either PVC or VCP material. Some of the older areas developed between the 1920's and 1950's, however, have 4- and 6-inch diameter pipes. These areas include central Wailuku, Happy Valley, Sand Hills, and the area around the Kahului Shopping Center. The County began using plastic pipe as a standard for construction in the late 1970's. Therefore, the collection systems for most of the newer areas are plastic pipe while the majority of the areas constructed prior to 1970 are clay pipe.

b. Treatment Facility

The Wailuku-Kahului WWRF was constructed in 1973 to serve as a regional wastewater reclamation facility for Kahului and nearby areas, including Wailuku and Spreckelsville. The WWRF provides secondary treatment of sewage and features an activated sludge biological treatment process, secondary clarification, and filtration. The final effluent, which is considered to be of excellent quality, is disposed of by eight gravity injection wells. The principal solids treatment and handling processes are aerobic digestion and centrifuge dewatering. The dewatered cake is composted at the Central Maui landfill.

The WWRF has a design capacity of 7.9 mgd average dry-weather flow (ADWF), 11.9 mgd peak dry-weather flow, and 15.8 mgd peak wet weather flow. Currently, approximately 6.958 mgd or 88 percent of its rated ADWF capacity of 7.9 has been allocated. The allocation of the WWRF's remaining capacity is shown in Table 5.

Table 5 WAILUKU-KAHULUI WASTEWATER RECLAMATION FACILITY PLANT CAPACITY STATUS DECEMBER 31, 2001			
Use	Allocation	Allocated	Available
1. Affordable Housing	.340	.054	.286
2. Long-term residential	.767	.484	.283
3. Public/quasi public	.100	.031	.069
4. Hotels	.070	.000	.070
5. All other developments (commercial)	.376	.142	.234
TOTAL	1.653	.711	.942

B. Assessment of Existing System Problems, Limitations and Opportunities

1. Collection System

A detailed assessment of the Wailuku-Kahului collection system was provided in the *Preliminary Wastewater System Analysis and Planning, Phase I, Wailuku-Kahului*

Collection System, County of Maui, June 1, 2001. The report provided the following recommendations:

- Perform closed-circuit television (CCTV) inspection on sewers with a high critical sewer rating in the next two years and on medium priority sewers over the next five years. Approximately 37,000 lineal feet of sewers were identified as high priority and an additional 39,000 lineal feet of sewers were designated as medium priority. The majority of high priority sewer lines were located in central Wailuku, Paukukalo and the Kahului Shopping Center/Maui Mall area while the majority of medium priority sewer lines were located in central Wailuku, Happy Valley, Sand Hills and the Kahului Shopping Center/Maui Mall area.
- Perform accelerated/enhanced preventative maintenance on low priority sewers. Approximately 32,000 lineal feet of sewers in the Wailuku-Kahului collection system have a low critical sewer rating. The report recommended that low priority sewers be placed at the top of the preventative maintenance list with detailed inspection forms filled out for each manhole accessed during maintenance.
- Investigate all spills. Inspection is recommended from the spill point downstream to the cause of the spill. If there is no immediately identifiable spill cause, a minimum of two reaches downstream of the spill point should be inspected.
- Perform manhole inspections. Sewer reaches at high risk of sulfide corrosion are recommended for manned entry manhole inspections.
- Develop standard inspection procedures and forms.
- Perform sulfide sampling. Sewer lines recommended for manhole inspections are also recommended for sulfide sampling.
- Use GIS as a management tool. The GIS system should be used as the key tool to manage CCTV inspections, manhole inspections, and sulfide data and to coordinate these field activities with activities recommended by hydraulic analysis of the system.
- Track spills and complaints. The GIS database should be used to track spills and complaints.
- Track maintenance activities. The GIS database should be tied into the County's computerized maintenance management system and used to track planned and completed maintenance activities.
- Track grease trap inspections. The KIVA database should be used to track the information collected from the County's Grease Inspection Program.
- Complete missing information. Information in the GIS database that is missing or has been assumed, should be verified and added to the database.

- Investigate the feasibility of small-diameter concrete lateral replacement program. In older areas of the collection system, many laterals were constructed of small diameter concrete pipes that exhibit a high frequency of structural deficiencies. Although maintenance of laterals is not the responsibility of the county, it was recommended that the County investigate the feasibility of a rehabilitation/replacement program to bring these areas to current standards.

2. Treatment Facility

The Wailuku-Kahului WWRF is not expected to reach capacity until after 2015. The County of Maui currently has a FY 2003 capital improvement project planned to study the feasibility of constructing a new Central Maui WWRF to replace the existing Wailuku-Kahului WWRF. The new Central Maui WWRF, if determined to be feasible, would replace the Wailuku-Kahului WWRF's capacity as well as provide the capability for future expansion to serve growth within Central Maui. The existing Wailuku-Kahului WWRF has limited land area for expansion and is located in the 100-year tsunami flood inundation zone.

The County of Maui also has an ongoing FY 2002 capital improvement project under construction to improve wastewater treatment process performance and reduce operation and maintenance requirements. Additionally, the project will provide modifications to mitigate damage and process disruption in the event of tsunami flooding.

3. Wastewater Reclamation

The feasibility of using reclaimed water from the Wailuku-Kahului Wastewater Treatment Facility was examined in a report prepared in June 1991, *Wailuku-Kahului Water Reuse Feasibility Study*. Three alternatives were proposed by the study, including two direct reuse alternatives and a groundwater recharge alternative. The first alternative involved using reclaimed water at the Maui Lani Development, Maui Central Park, Kanaha Pond, Kanaha Beach Park, and the Kahului Airport/Entrance Road. This alternative had a capital cost of \$23 to \$27 million and unit cost (capital cost plus operation and maintenance) of \$1,000 to \$1,200 acre-ft. The second alternative involved using reclaimed water at the three sites closest to the Wailuku-Kahului Wastewater Treatment Facility; Kanaha Pond, Kanaha Beach Park, and the Kahului Entrance Road. This alternative had a capital cost of \$3.9 to \$4.6 million and unit cost of \$1,400 to \$1,700 acre-ft. The groundwater recharge alternative proposed discharging reclaimed water in an area between the Maui Lani Development and Waikapu to supplement local groundwater supplies. The capital cost for this alternative was estimated at \$25 to \$30 million and the unit cost was estimated at \$300 to \$400 per acre-ft.

As compared to the cost of developing new supplies of potable water, the cost of constructing water reclamation facilities was relatively high, which may make such facilities economically unviable. For Central Maui, the estimated unit cost of developing new potable water supplies was \$600 to \$900 per acre-ft. The estimated unit cost for

developing new wells, such as for Maui Lani or Maui Central Park, was much lower at \$150 to \$250 per acre-ft. The report recommended that the County monitor the effect of recent changes in irrigation practices from furrow to drip irrigation. Under furrow irrigation, a large portion of the water applied infiltrates and recharges the basal aquifer. Under drip irrigation, the amount of recharge to the basal aquifer may be considerably less. Consequently, if the change in irrigation practices affects the quantity or quality of groundwater, reclamation may become a viable alternative.

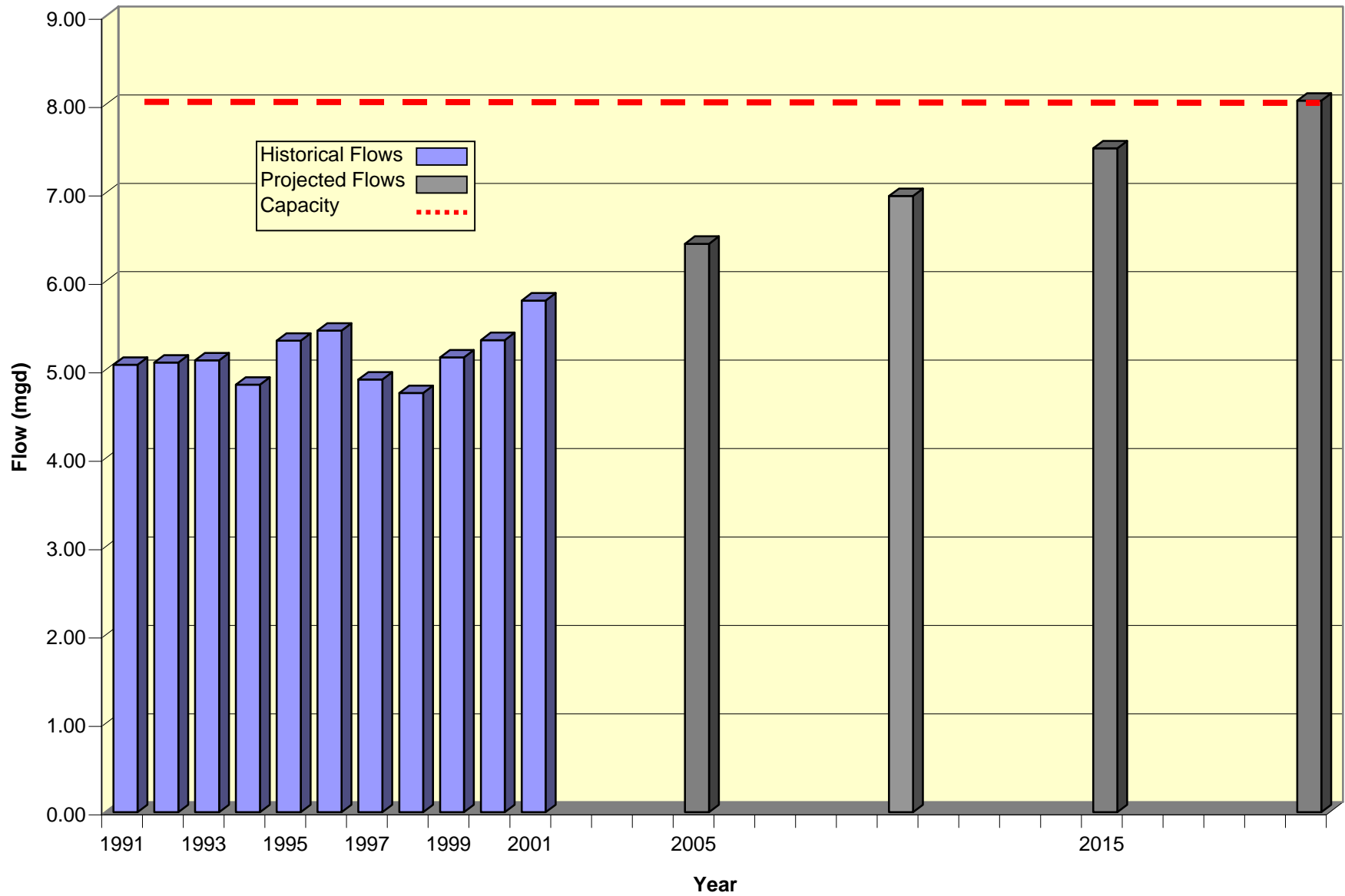
C. Assessment of Future System Requirements

As noted in Section II of this report, wastewater flow projections were developed for each county wastewater reclamation facility by applying per capita flow rates to the population projections contained in the *Maui Community Plan Update Program: Socio-Economic Forecast, Phase I Report, Pre-final version*. For the Wailuku-Kahului WWRF, a resident per capita flow rate of 137 gpd and a visitor per capita flow rate of 156 gpd was used to project wastewater flows. Table 6 and Chart 1 provide projected wastewater flows to the Wailuku-Kahului WWRF to year 2020. Based on the projections, the Wailuku-Kahului WWRF is expected to be at its design capacity of 7.9 mgd sometime between 2015 and 2020.

TABLE 6
WAILUKU-KAHULUI WASTEWATER RECLAMATION FACILITY
PROJECTED WASTEWATER FLOWS

Year	Resident Population	Visitor Population	Total Resident Flows (mgd)	Total Visitor Flows (mgd)	Total Flows (mgd)
2005	45,175	1,256	6.23	.195	6.43
2010	48,992	1,349	6.76	.210	6.97
2015	52,844	1,444	7.29	.225	7.51
2020	56,626	1,547	7.81	.241	8.05

CHART 1
Wailuku-Kahului Wastewater Reclamation Facility
Historical and Projected Flows



IV. LAHAINA WASTEWATER SYSTEM

A. Existing System/Service Area

1. Tributary Service Area Characteristics

The Lahaina Wastewater Reclamation Facility and its tributary sewer system provide wastewater collection, treatment, and disposal for the West Maui region from Puamana to Kapalua. These facilities, except for a portion of the system in Kapalua, are owned and operated by the County of Maui.

Residential communities in the service area include Puamana, Lahaina Town, Kapalua, and Napili-Honokowai. According to the 2000 census, the resident population of the Lahaina-Napili region was 17,967. This represents an increase of about 23% from the 1990 census population.

Visitor oriented developments are concentrated at Kaanapali and Kapalua. According to the *Maui Community Plan Update Program: Socio-Economic Forecast*, in 2000 the West Maui Community Planning District had a resident population of 17,967 and an average daily visitor census of 23,356. This represents an increase of 23% and 4%, respectively, from 1990 population figures.

2. Existing System Characteristics

a. Collection System

The collection system has two segments, the Napili side to the North and the Lahaina side to the south. Wastewater is transported to the Lahaina Wastewater Reclamation Facility along major trunk lines, which are generally located within Honoapiilani Highway and Front Street. The collection system consists of 16 County owned and operated pumping stations, 74,670 feet of gravity sewer, and 10,700 feet of force main. The majority of sewer lines in the region are 8-inch diameter pipes and are predominately constructed of either PVC or VCP. The County began using plastic pipe as a standard for construction in the late 1970's. Therefore, the collection systems for most of the newer areas are plastic pipe while the majority of the areas constructed prior to 1970 are clay pipe.

b. Treatment Facility

The Lahaina Wastewater Reclamation Facility is actually two separate wastewater reclamation facilities on one site. The 1975 WWRF was constructed in the mid-1970's and originally had a rated average flow capacity of 3.2 mgd. The second WWRF, completed in 1985, originally had a rated capacity of 3.5 mgd. Both WWRFs feature similar treatment processes: screening, grit removal, activated sludge with mechanical aeration, secondary clarification, chlorine disinfection, and disposal by injection wells. The 1975 WWRF has an effluent filter preceding disposal. In 1995 the facilities were upgraded to a combined design capacity of 9.0 mgd average dry-weather flow (ADWF),

when the design capacity of the 1975 WWRF and 1985 WWRF were increased to 4.8 and 4.2 mgd respectively. 2.3 mgd ADWF of the facility's design capacity is allocated to AMFAC, Kapalua, and the HFDC who funded the upgrade project. Currently, 6.138 mgd or 92 percent of the facility's ADWF capacity of 6.7 mgd has been allocated.

c. Wastewater Reclamation

The Lahaina WWRF has an ultraviolet (UV) disinfection system that treats approximately 1.2 mgd of the final effluent as reclaimed water for irrigation purposes. The reclaimed water is used by the Kaanapali Resort for golf course and roadway landscape irrigation, and the Lahaina WWRF. The Lahaina WWRF also has a fill station that allows contractors to fill water wagons for dust control purposes. The remainder of the effluent is disposed of by gravity injection wells.

The current reclaimed water distribution system consists of a pump station at the Lahaina WWRF and a 16-inch main located within the Honoapiilani Highway extending from the Lahaina WWRF to an irrigation pond located within the Kaanapali Resort golf course.

B. Assessment of Existing System Problems, Limitations and Opportunities

1. Collection System

A detailed assessment of the Lahaina collection system was provided in the *Preliminary Wastewater System Analysis and Planning, Phase I, Lahaina Collection System, County of Maui*, June 1 2001. The report provided the following recommendations:

- Perform closed-circuit television (CCTV) inspection on sewers with a high critical sewer rating in the next two years and on medium priority sewers over the next five years. Approximately 32,000 lineal feet of sewers were identified as high priority and an additional 14,000 lineal feet of sewers were designated as medium priority. The majority of high priority sewer lines were located in the central Lahaina town area, in the Kaanapali beach resort area, or along Honoapiilani Highway from Kaanapali up to Napili. These sewers were given high priority ratings due to the potential consequences, rather than risk of failure. Generally, in the West Maui region, the collection system is constructed in series, where one pump station will pass wastewater flows into a gravity sewer, which flows to the next pump station, and continues in this manner down the line from pump station to pump station until the flow reaches the WWRF. A collection system failure along this major flow artery could potentially affect a very large area upstream of the problem location. The high priority sewers tend to be large in diameter, carry relatively large flows, lie close to the ocean, and parallel to major traffic thoroughfares.

Approximately 14,000 linear feet of sewer lines were designated as medium priority. These sewers are scattered throughout the system, but tend to be located close to the coastline.

- Perform accelerated/enhanced preventative maintenance on low priority sewers. Approximately 22,000 lineal feet of sewers in the Wailuku-Kahului collection system have a low critical sewer rating. The report recommended that low priority sewers be placed at the top of the preventative maintenance list with detailed inspection forms filled out for each manhole accessed during maintenance.
- Investigate all spills. Inspection is recommended from the spill point downstream to the cause of the spill. If there is no immediately identifiable spill cause, a minimum of two reaches downstream of the spill point should be inspected.
- Perform manhole inspections. Sewer reaches at high risk of sulfide corrosion are recommended for manned entry manhole inspections.
- Develop standard inspection procedures and forms.
- Perform sulfide sampling. Sewer lines recommended for manhole inspections are also recommended for sulfide sampling.
- Use GIS as a management tool. The GIS system should be used as the key tool to manage CCTV inspections, manhole inspections, and sulfide data and to coordinate these field activities with activities recommended by hydraulic analysis of the system.
- Track spills and complaints. The GIS database should be used to track spills and complaints.
- Track maintenance activities. The GIS database should be tied into the County's computerized maintenance management system and used to track planned and completed maintenance activities.
- Track grease trap inspections. The County's KIVA database should be used to track the information collected from the County's Grease Inspection Program.
- Complete missing information. Information in the GIS database that is missing or has been assumed, should be verified and added to the database.

2. Treatment Facility

Based on projected wastewater flow data, the Lahaina WWRF will have sufficient capacity beyond 2020.

Expansion of the reuse program is vital to the continued growth within the Lahaina area since increased growth will result in an increase of effluent generated. The County of Maui currently has a FY 2002 capital improvement project titled "West Maui Effluent Reuse Preliminary Engineering Report" that will evaluate existing and potential users, identify potential offsite storage requirements, storage locations, and forecast other R-1 infrastructure improvements. Maui Land and Pineapple Company has expressed interest

in using approximately 500,000 gpd of the reclaimed water as well as the possibility of constructing a reclaimed water tank in the mauka Kaanapali Resort area to serve future development in the area.

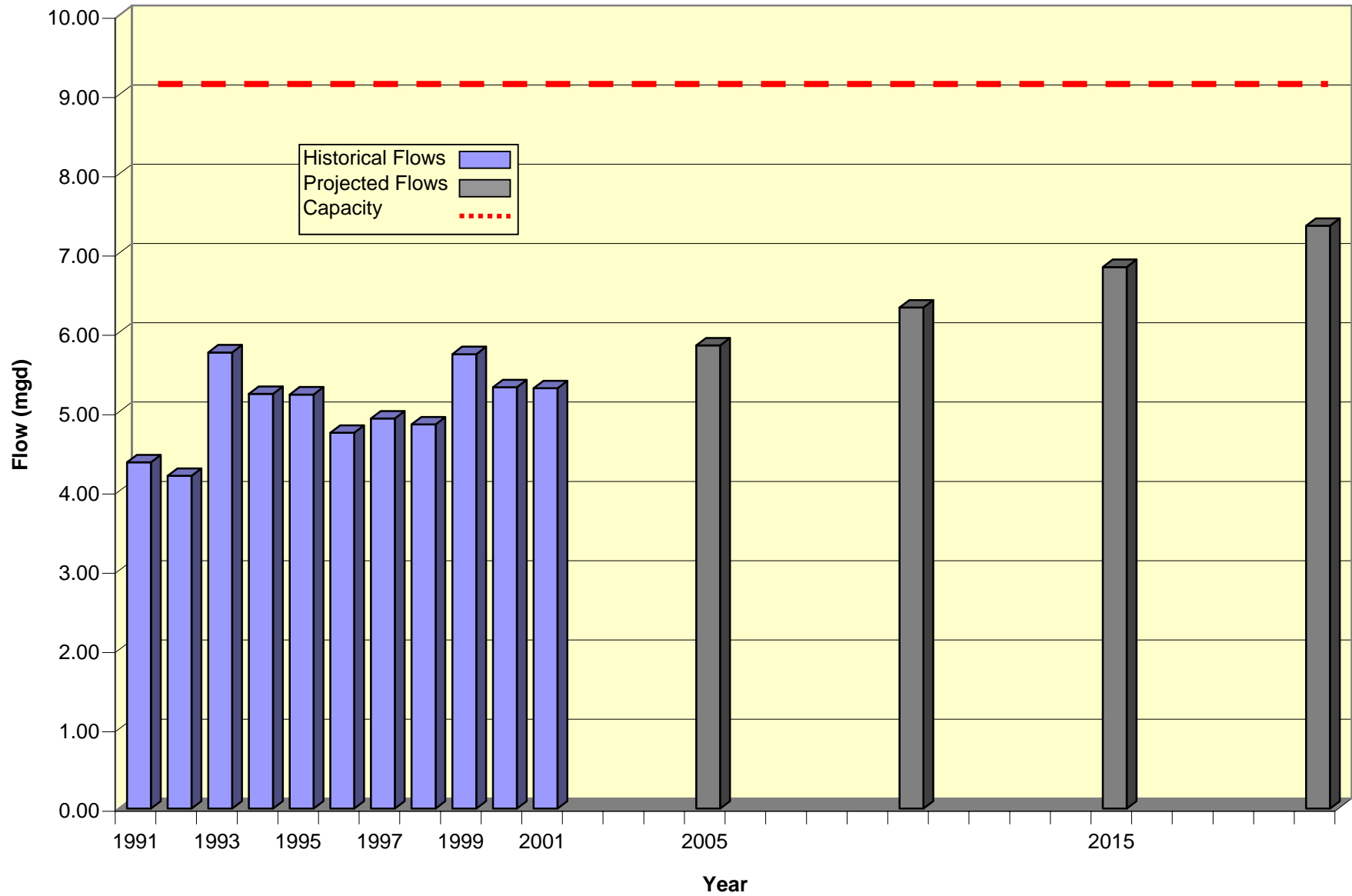
C. Assessment of Future System Requirements

As noted in Section II of this report, wastewater flow projections were developed for each county wastewater reclamation facility by applying per capita flow rates to the population projections contained in the *Maui Community Plan Update Program: Socio-Economic Forecast, Phase I Report, Pre-final version*. For the Lahaina WWRF, a resident per capita flow rate of 99.6 gpd and a visitor per capita flow rate of 156 gpd was used to project wastewater flows. Table 7 and Chart 2 provide projected wastewater flows to the Lahaina WWRF to year 2020. Based on the projections, the Lahaina WWRF is expected have sufficient capacity beyond 2020.

TABLE 7
LAHAINA WASTEWATER RECLAMATION FACILITY
PROJECTED WASTEWATER FLOWS

Year	Resident Population	Visitor Population	Total Resident Flows (mgd)	Total Visitor Flows (mgd)	Total Flows (mgd)
2005	19,612	25,010	1.95	3.89	5.84
2010	21,322	27,005	2.12	4.20	6.32
2015	23,047	29,143	2.30	4.53	6.83
2020	24,741	31,438	2.46	4.89	7.35

CHART 2
Lahaina Wastewater Reclamation Facility
Historical and Projected Flows



V. KIHEI DISTRICT WASTEWATER SYSTEM

A. Existing System/Service Area

1. Tributary Service Area Characteristics

The Kihei Wastewater Service Area is basically comprised of four communities: Maalaea, Kihei, Wailea and Makena. For reference, the wastewater service area is divided into the North and South Kihei Collection Systems.

a. North Kihei Collection System

The North Kihei Collection System encompasses four general sub-areas: Maalaea, Project District 10 (the old Puunene Airport), North Kihei, and the Maui Research and Technology Park. Only the North Kihei and Maui Research and Technology Park sub-areas, however, generate flows that are collected and treated at the Kihei Wastewater Reclamation Facility.

Maalaea is located at the extreme northeast portion of the service area and is separated from Kihei by Kealia Pond and its surrounding flats. At present, sewer service in Maalaea consists of small individual private sewer systems and no sewage flows from this area are treated by the County.

The Old Puunene Airport area encompasses approximately 436-acres and is designated as Project District 10 by the Kihei-Makena Community Plan. The area is proposed for industrial expansion to meet future industrial needs.

The North Kihei sub-area includes all of the urban lands designated by the Kihei-Makena Community Plan between Kealia Pond to the north and Kalama Park to the south.

The Maui Research and Technology Park Project District encompasses a 385-acre area mauka of Piilani Highway and north of the Kihei Wastewater Reclamation Facility. The park is intended to provide alternative employment in non-polluting research and technology facilities. Flows from the park are routed to the Kihei WWRF through two privately operated wastewater pump stations and private gravity lines located at the park.

b. South Kihei Collection System

The South Kihei Service Area includes the sub-areas of Makena, Wailea, and South Kihei. In the late 1980's and early 1990's this area underwent rapid development to service the growing visitor industry.

Makena is at the extreme southern end of the Kihei Wastewater Service Area where Seibu Hawaii has a resort development planned. At present, there is a golf course, tennis facilities, and a 300-room hotel with its own sewage treatment facilities. The area has been developed substantially below its maximum zoning potential. Smaller landowners

dot the shoreline with various zoned properties. Seibu Hawaii is currently constructing a private 0.6 mgd design capacity treatment plant to serve future development in the area.

The Wailea sub-area consists primarily of the 1,500-acre Wailea Resort Development, a portion of Wailea 670 (Project District 9), and a portion of Seibu Hawaii's resort. The resort community of Wailea consists of hotels, condominium apartments, commercial business centers and single-family subdivisions.

The area between Kaukahi Street and Kilohana Street consists primarily of hotels, homes, and resorts. Wastewater from this area is collected by private sewers and transported to the Kihei WWRF. Maui Meadows, a residential subdivision located mauka of the Wailea sub-area, has been developed without any public wastewater collection systems or dry sewers.

2. Existing System Characteristics

a. Collection System

The Kihei District wastewater collection system consists of 10 sewage pump stations that route flows to the Kihei Wastewater Reclamation Facility. The majority of sewer lines in the Kihei district are 8-inch diameter pipes and constructed of PVC material. The County began using plastic pipe as a standard for construction in the late 1970's. Therefore, the collection systems for most of the newer areas are plastic pipe while the majority of the areas constructed prior to 1970 are clay pipe.

b. Treatment Facility

The Kihei Wastewater Reclamation Facility, owned by the County of Maui, was constructed in 1975 with a design capacity of 4.0 mgd. In 1989 and 1998, the WWRF's designed capacity was expanded to 6.0 mgd and 8.0 mgd, respectively. The WWRF provides secondary treatment of sewage and features activated sludge biological treatment process, secondary clarification and filtration. The principal solids treatment and handling processes are aerobic digestion and centrifuge dewatering. The dewatered cake is composted at a landfill. Currently, 5.937 mgd or 74% of its design capacity of 8.0 mgd has been allocated.

c. Effluent Reuse System

The Kihei Wastewater Reclamation Facility has an ultraviolet (UV) disinfection system that treats approximately 1.7 mgd of the final effluent as reclaimed water for irrigation purposes. A number of water users including the Piilani North Park, Piilani subdivision, Piilani Shopping Center, Spencer Homes, Haleakala Ranch, Haggai Institute, Rojac Construction, Goodfellow Brothers, Monsanto, Micro Gaia, Elleair Maui Golf Course, Kalama Park, Lokelani Intermediate School, Kihei Elementary School, Kihei Fire Station, Kihei Library, Kihei Commercial Center and the Kihei Community Center use the reclaimed water for irrigation. The remaining reclaimed water is disposed of by three

TABLE 8
KIHEI WASTEWATER RECLAMATION FACILITY
PLANT CAPACITY STATUS
DECEMBER 31, 2001

Use	Allocation	Allocated	Available
1. Long-term residential	.200	.338	(.138)
2. Public/quasi public	.050	.020	.030
3. Kihei R&T Park	.027	.000	.027
4. Wailea (long-term residential)	.047	.001	.046
Wailea (unspecified uses)	.015	.000	.015
5. All other developments (commercial)	.207	.124	.083
TOTAL	.546	.483	.063

gravity injection wells. The County of Maui is currently looking at expanding the reclaimed water distribution system to provide water to other potential users. The current reclaimed water distribution system consists of a 1.0 million-gallon reservoir that was constructed in 1997 and a distribution lines to the Elleair Golf Club, Kalama Park, and along the North-South Collector Road alignment to Piikea Street. The allocation of the plant's remaining capacity is shown in Table 8.

B. Assessment of Existing System Problems, Limitations and Opportunities

1. Collection System

A detailed assessment of the Kihei collection system was provided in the *Preliminary Wastewater System Analysis and Planning, Phase I, Kihei Collection System, County of Maui*, June 22, 2001. The report provided the following recommendations:

- Perform closed-circuit television (CCTV) inspection on sewers with a high critical sewer rating in the next two years and on medium priority sewers over the next five years. Approximately 17,000 lineal feet of sewer lines in the Kihei collection system were identified as high priority and an additional 7,000 lineal feet of sewer lines were designated as medium priority. The majority of high priority sewer lines were located along South Kihei Road close to the shoreline while medium priority sewers were scattered throughout the Kihei region, generally near the shoreline.
- Perform accelerated/enhanced preventative maintenance on low priority sewers. Approximately 13,000 lineal feet of sewers in the Wailuku-Kahului collection system have a low critical sewer rating. The report recommended that low priority sewers be placed at the top of the preventative maintenance list with detailed inspection forms filled out for each manhole accessed during maintenance.

- Investigate all spills. Inspection is recommended from the spill point downstream to the cause of the spill. If there is no immediately identifiable spill cause, a minimum of two reaches downstream of the spill point should be inspected.
- Perform manhole inspections. Sewer reaches at high risk of sulfide corrosion are recommended for manned entry manhole inspections.
- Develop standard inspection procedures and forms.
- Perform sulfide sampling. Sewer lines recommended for manhole inspections are also recommended for sulfide sampling.
- Use GIS as a management tool. The GIS system should be used as the key tool to manage CCTV inspections, manhole inspections, and sulfide data and to coordinate these field activities with activities recommended by hydraulic analysis of the system.
- Track spills and complaints. The GIS database should be used to track spills and complaints.
- Track maintenance activities. The GIS database should be tied into the County's computerized maintenance management system and used to track planned and completed maintenance activities.
- Track grease trap inspections. The KIVA database should be used to track the information collected from the County's Grease Inspection Program.
- Complete missing information. Information in the GIS database that is missing or has been assumed should be verified and added to the database.

2. Treatment Facility

Based on the projected wastewater flow data, the Kihei WWRF will have sufficient capacity beyond 2020.

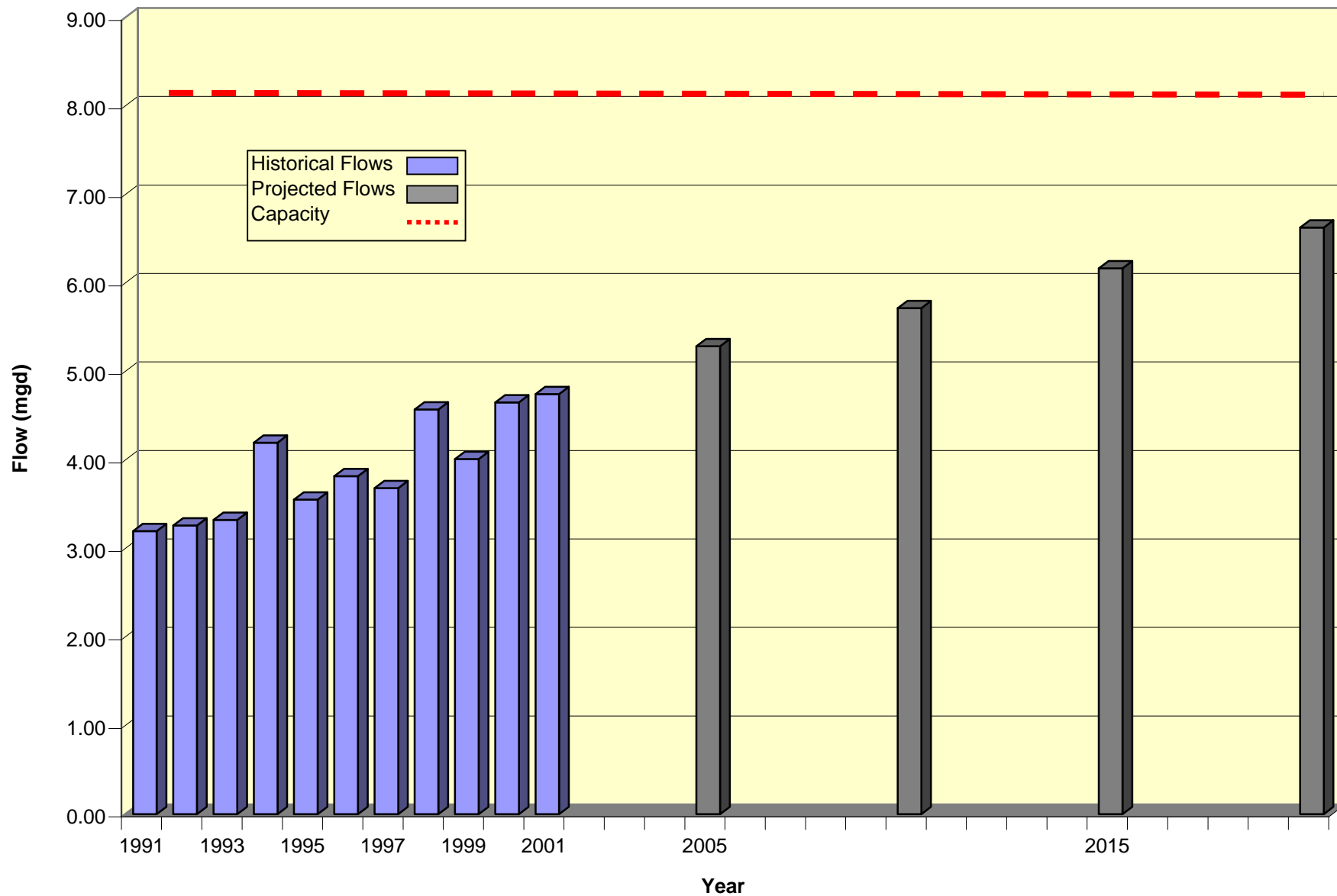
C. Assessment of Future System Requirements

As noted in Section II of this report, wastewater flow projections were developed for each county wastewater reclamation facility by applying per capita flow rates to the population projections contained in the *Maui Community Plan Update Program: Socio-Economic Forecast, Phase I Report, Pre-final version*. For the Kihei WWRF, a resident per capita flow rate of 106.1 gpd and a visitor per capita flow rate of 156 gpd was used to project wastewater flows. Table 9 and Chart 3 provide projected wastewater flows to the Kihei WWRF to year 2020. Based on the projections, the Kihei WWRF is expected to be at its design capacity of 8.0 mgd well after 2020.

TABLE 9
KIHEI WASTEWATER RECLAMATION FACILITY
PROJECTED WASTEWATER FLOWS

Year	Resident Population	Visitor Population	Total Resident Flows (mgd)	Total Visitor Flows (mgd)	Total Flows (mgd)
2005	25,000	17,788	2.65	2.77	5.42
2010	27,214	19,151	2.89	2.98	5.87
2015	29,449	20,573	3.12	3.2	6.32
2020	31,642	22,106	3.36	3.44	6.80

CHART 3
Kihei Wastewater Reclamation Facility
Historical and Projected Flows



VI. MAKAWAO-PUKALANI-KULA DISTRICT WASTEWATER SYSTEM

A. Existing System/Service Area

1. Tributary Service Area Characteristics

The Makawao-Pukalani-Kula region is rural and agricultural in nature, although Makawao and Pukalani are becoming suburban communities for the employment centers in Wailuku-Kahului and the resort areas of the island. The majority of the region is not served by County wastewater facilities. Only the Haliimaile subdivision is served by a County collection system while a portion of the Pukalani area is served by a private wastewater treatment system. Cesspools or septic tanks serve the remainder of the area.

2. Existing System Characteristics

The Haliimaile subdivision is served by a County owned wastewater collection system that consists entirely of 8-inch pipes constructed primarily of VCP material. Wastewater is transported to a wastewater pond owned and operated by Maui Land and Pineapple Company.

The Pukalani subdivision is served by a private sewage treatment facility operated by Sports Shinko Co. Ltd. The facility serves 500 homes in the subdivision and processes 1.7 million gallons per week. While the facility can accommodate up to 1,000 homes, there are no plans to increase flows received.

The remainder of the region is served by individual cesspools or septic systems disposing effluent into injection wells.

B. Assessment of Existing System Problems, Limitations and Opportunities

1. Collection System

A detailed assessment of the Haliimaile collection system was provided in the *Preliminary Wastewater System Analysis and Planning, Phase I, Haliimaile Collection System, County of Maui*, June 22, 2001. The assessment identified no high or medium priority sewer lines. The report provided the following recommendations:

- Investigate all spills. Inspection is recommended from the spill point downstream to the cause of the spill. If there is no immediately identifiable spill cause, a minimum of two reaches downstream of the spill point should be inspected.
- Perform manhole inspections. Sewer reaches at high risk of sulfide corrosion are recommended for manned entry manhole inspections.
- Develop standard inspection procedures and forms.

- Perform sulfide sampling. Sewer lines recommended for manhole inspections are also recommended for sulfide sampling.
- Use GIS as a management tool. The GIS system should be used as the key tool to manage CCTV inspections, manhole inspections, and sulfide data and to coordinate these field activities with activities recommended by hydraulic analysis of the system.
- Track spills and complaints. The GIS database should be used to track spills and complaints.
- Track maintenance activities. The GIS database should be tied into the County's computerized maintenance management system and used to track planned and completed maintenance activities.
- Track grease trap inspections. The GIS database should be used to track the information collected from the County's Grease Inspection Program.
- Complete missing information. Information in the GIS database that is missing or has been assumed should be verified and added to the database.

2. Treatment Facility

The County of Maui has two FY 2008 capital improvement projects planned to provide a sewer master plan study for both Upcountry and East Maui.

C. Assessment of Future System Requirements

With the exception of developments located in the Haliimaile or Pukalani subdivisions, it is anticipated that wastewater from new developments will be accommodated through individual wastewater systems.

VII. MOLOKAI WASTEWATER SYSTEM

A. Existing System Service Area

1. Tributary Service Area Characteristics

Wastewater service on the island of Molokai is provided by the County of Maui in the town of Kaunakakai and the Kualapuu subdivision. Wastewater collected by the Kaunakakai system is conveyed to the Kaunakakai Wastewater Reclamation Facility for treatment and reuse as recycled irrigation water with the excess disposed of via injection wells. Wastewater collected by the Kualapuu system is conveyed to a private wastewater treatment facility owned and operated by Molokai Ranch. According to the *Maui Community Plan Update Program: Socio-Economic Forecast*, in 2000 the island of Molokai had a resident population of 7,404 and an average daily visitor census of 905. Based on census tract population data, it is estimated that in 2000 the resident population served by the Kaunakakai WWRF was about 2,500.

2. Existing System Characteristics

a. Collection System

Wastewater from the town of Kaunakakai is routed by the Kaunakakai WWPS to the Kaunakakai Wastewater Reclamation Facility located near Kaunakakai Harbor. The vast majority of lines in the Kaunakakai system (85%) are 8-inch diameter pipes constructed of VCP or PVC material. Only a small portion of the Kaunakakai collection system (about 6%) consists of 6-inch diameter pipes. Sewer lines larger than 8-inches in diameter comprise about 9% of the Kaunakakai collection system. Information regarding line sizes and material for much of the Kualapuu collection system is presently not available. The County began using plastic pipe as a standard for construction in the late 1970's. Therefore, the collection systems for most of the newer areas are plastic pipe while the majority of the areas constructed prior to 1970 are clay pipe.

b. Treatment Facility

The Kaunakakai Wastewater Reclamation Facility is owned by the County of Maui and was constructed in 1969 with a design capacity of 0.086 mgd. In 1984, the WWRF's design capacity was increased to 0.3 mgd. The WWRF provides secondary treatment of sewage and features rotating biological contractors, secondary clarifier, effluent filters, and chlorinators. Currently 0.289 mgd or 96% of the WWRF's design capacity of 0.3 mgd has been allocated. Reclaimed water from the Kaunakakai WWRF is used for irrigation purposes with the excess disposed of by injection wells.

B. Assessment of Existing System Problems, Limitations and Opportunities

1. Collection System

A detailed assessment of the Kaunakakai collection system was provided in the *Preliminary Wastewater System Analysis and Planning, Phase I, Molokai Collection System, County of Maui*, June 22, 2001. The report provided the following recommendations:

- Perform closed-circuit television (CCTV) inspection on sewers with a high critical sewer rating in the next two years and on medium priority sewers over the next five years. Approximately 928 lineal feet of sewer lines in the Kaunakakai collection system were identified as high priority and an additional 1,200 lineal feet of sewer lines were designated as medium priority. The high priority sewer lines were located along Ala Mamala Avenue and Mahalo Place in Kaunakakai Town while the medium priority sewer lines were scattered in the residential areas north of Kolapa Place and Ala Mamala Avenue in Kaunakakai Town.
- Perform accelerated/enhanced preventative maintenance on low priority sewers. Approximately 4,600 lineal feet of sewers in the Kaunakakai collection system have a low critical sewer rating. All of the lines are in Kaunakakai Town. The report recommended that low priority sewers be placed at the top of the preventative maintenance list with detailed inspection forms filled out for each manhole accessed during maintenance.
- Investigate all spills. Inspection is recommended from the spill point downstream to the cause of the spill. If there is no immediately identifiable spill cause, a minimum of two reaches downstream of the spill point should be inspected.
- Perform manhole inspections. Sewer reaches at high risk of sulfide corrosion are recommended for manned entry manhole inspections.
- Develop standard inspection procedures and forms.
- Perform sulfide sampling. Sewer lines recommended for manhole inspections are also recommended for sulfide sampling.
- Use GIS as a management tool. The GIS system should be used as the key tool to manage CCTV inspections, manhole inspections, and sulfide data and to coordinate these field activities with activities recommended by hydraulic analysis of the system.
- Track spills and complaints. The GIS database should be used to track spills and complaints.

- Track maintenance activities. The GIS database should be tied into the County's computerized maintenance management system and used to track planned and completed maintenance activities.
- Track grease trap inspections. The GIS database should be used to track the information collected from the County's Grease Inspection Program.
- Complete missing information. Information in the GIS database that is missing or has been assumed should be verified and added to the database.

2. Treatment Facility

Although the wastewater flow projections for the Kaunakakai WWRF indicate that the facility will reach capacity before 2010, the Wastewater Reclamation Division has no immediate plans to increase treatment plant capacity. The Wastewater Reclamation Division does not foresee any major developments within the Kaunakakai WWRF service area that would increase wastewater flows. Additionally, the Wastewater Reclamation Division has successfully implemented a low-flow fixture replacement program that has reduced wastewater flows to the Kaunakakai WWRF. Chart 4 shows the reduction in flows to the Kaunakakai WWRF in the 1990's. The County plans to initiate a facility plan study to determine expansion options when the average dry weather flow of the Kaunakakai WWRF reaches 75% of the facility's design flow.

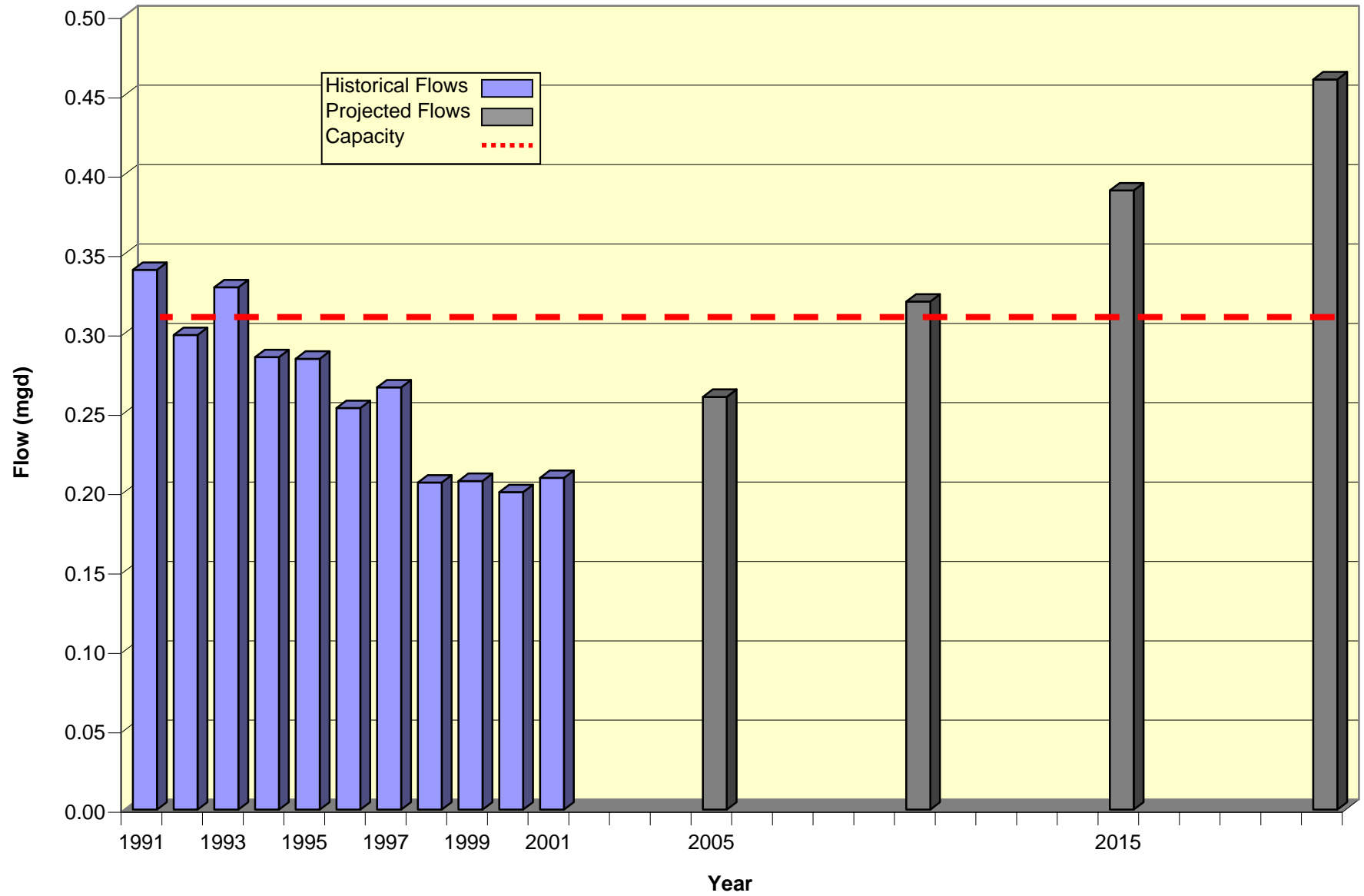
C. Assessment of Future System Requirements

As noted in Section II of this report, wastewater flow projections were developed for each county wastewater reclamation facility by applying per capita flow rates to the population projections contained in the *Maui Community Plan Update Program: Socio-Economic Forecast, Phase I Report, Pre-final version*. For the Kaunakakai WWRF, a resident per capita flow rate of 80.3 gpd was used to project wastewater flows. Wastewater flows attributable to visitors were not included in the projections because the majority of visitor units on Molokai are not connected to the Kaunakakai WWRF. Table 10 and Chart 4 provide projected wastewater flows to the Kaunakakai WWRF to year 2020. Based on the projections, the Kaunakakai WWRF is expected to be at its design capacity of 0.3 mgd between 2005 and 2010.

TABLE 10
KAUNAKAKAI WASTEWATER RECLAMATION FACILITY
PROJECTED WASTEWATER FLOWS

Year	Resident Population	Visitor Population	Total Resident Flows (mgd)	Total Visitor Flows (mgd)	Total Flows (mgd)
2005	3,276	--	0.26	--	0.26
2010	3,971	--	0.32	--	0.32
2015	4,806	--	0.39	--	0.39
2020	5,690	--	0.46	--	0.46

CHART 4
Kaunakakai Wastewater Reclamation Facility
Historical and Projected Flows



VIII. LANAI WASTEWATER SYSTEM

A. Existing System Service Area

The Lanai wastewater system, the smallest of the County's systems, services the vacation resort, small businesses and residential population of the Lanai City area. Wastewater collected by the system is conveyed to the Lanai Wastewater Reclamation Facility for treatment. According to the *Maui Community Plan Update Program: Socio-Economic Forecast*, in 2000 the island of Lanai had a resident population of 3,193 and an average daily visitor census of 1,131. Based on census tract population data, it is estimated that in 2000 the resident population served by the Lanai WWRF was 3,170.

1. Existing System Characteristics

a. Collection System

The Lanai wastewater system consists of approximately 11 miles of gravity sewers with no County owned pump stations or force mains. The vast majority of the sewer lines are 8-inches in diameter and constructed of VCP or PVC. Approximately 7 percent of the collection system is constructed of 10- to 12-inch diameter pipes and about 4 percent consists of pipes larger than 12 inches in diameter. The County began using plastic pipe as a standard for construction in the late 1970's. Therefore, the collection systems for most of the newer areas are plastic pipe while the majority of the areas constructed prior to 1970 are clay pipe.

b. Treatment Facility

The Lanai Wastewater Reclamation Facility is owned by the County of Maui and was constructed in 1982 with a design capacity of 0.5 mgd. Currently, 0.325 mgd or 65% of its design capacity of 0.5 mgd has been allocated.

c. Effluent Reuse

All effluent from the Lanai WWRF is used by the Koele golf course.

B. Assessment of Existing System Problems, Limitations and Opportunities

1. Collection System

A detailed assessment of the Lanai collection system was provided in the *Preliminary Wastewater System Analysis and Planning, Phase I, Lanai Collection System, County of Maui*, June 22, 2001. The report provided the following recommendations:

- Perform closed-circuit television (CCTV) inspection on medium priority sewers over the next five years. Approximately 461 lineal feet of sewer lines in the Lanai collection system were identified as medium priority. A majority of these sewers are

located downstream of the pump station force main outlet. The only segment in the Lanai collection system that was given a high priority rating has already been inspected.

- Perform accelerated/enhanced preventative maintenance on low priority sewers. Approximately 1,152 lineal feet of sewers in the Lanai collection system have a low critical sewer rating. The lines are located along the reach between the pump station force main outlet and the WWRF, and on Fifth Street. The report recommended that low priority sewers be placed at the top of the preventative maintenance list with detailed inspection forms filled out for each manhole accessed during maintenance.
- Investigate all spills. Inspection is recommended from the spill point downstream to the cause of the spill. If there is no immediately identifiable spill cause, a minimum of two reaches downstream of the spill point should be inspected.
- Perform manhole inspections. Sewer reaches at high risk of sulfide corrosion are recommended for manned entry manhole inspections.
- Develop standard inspection procedures and forms.
- Perform sulfide sampling. Sewer lines recommended for manhole inspections are also recommended for sulfide sampling.
- Use GIS as a management tool. The GIS system should be used as the key tool to manage CCTV inspections, manhole inspections, and sulfide data and to coordinate these field activities with activities recommended by hydraulic analysis of the system.
- Track spills and complaints. The GIS database should be used to track spills and complaints.
- Track maintenance activities. The GIS database should be tied into the County's computerized maintenance management system and used to track planned and completed maintenance activities.
- Track grease trap inspections. The GIS database should be used to track the information collected from the County's Grease Inspection Program.
- Complete missing information. Information in the GIS database that is missing or has been assumed should be verified and added to the database.

2. Treatment Facility

Based on projected wastewater flow data, the Lanai WWRF will have sufficient capacity well beyond 2020.

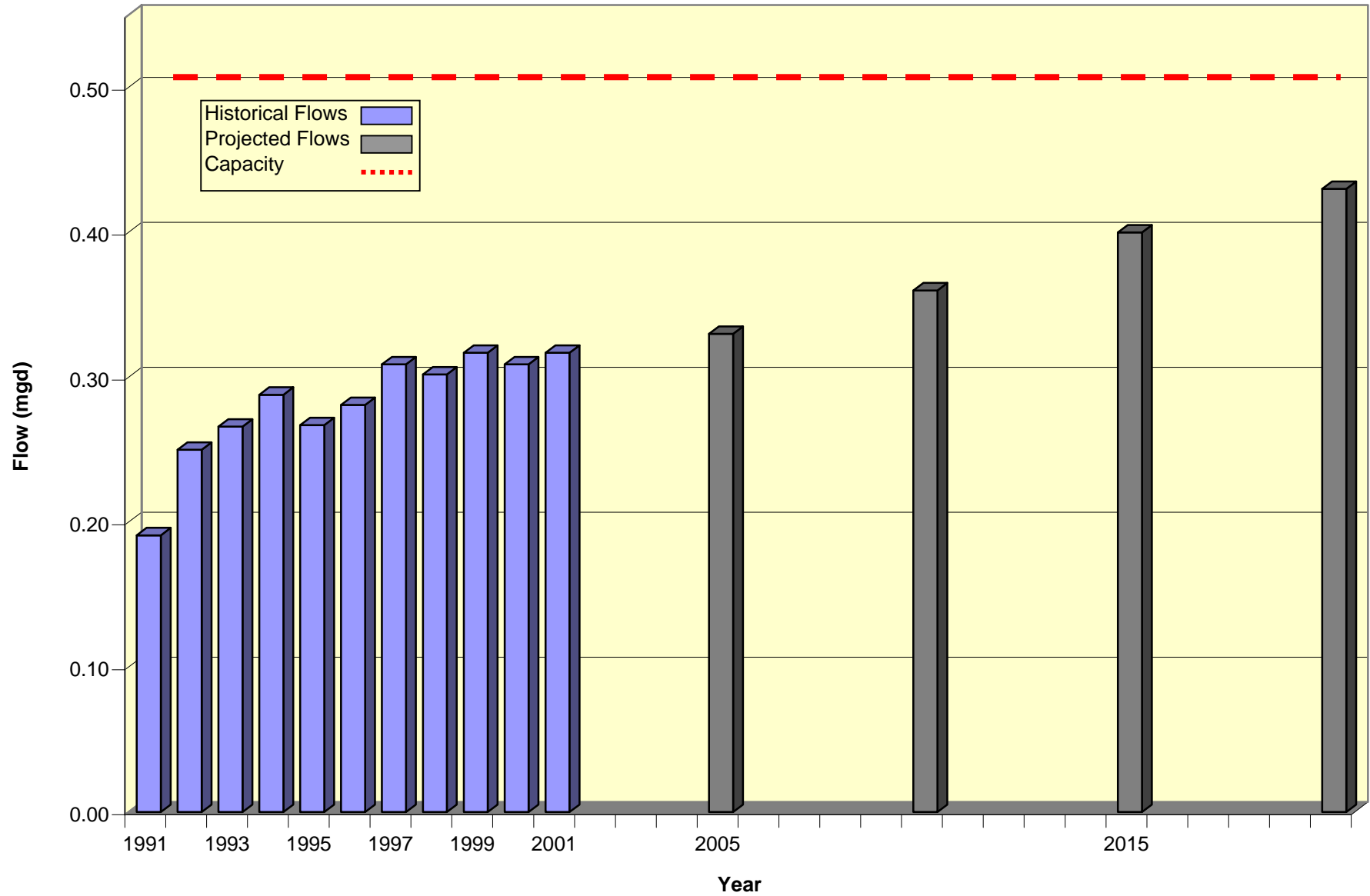
C. Assessment of Future System Requirements

As noted in Section II of this report, wastewater flow projections were developed for each county wastewater reclamation facility by applying per capita flow rates to the population projections contained in the *Maui Community Plan Update Program: Socio-Economic Forecast, Phase I Report, Pre-final version*. For the Lanai WWRF, a resident per capita flow rate of 97.5 gpd was used to project wastewater flows. Wastewater flows attributable to visitors were not included in the projections because the majority of visitor units on Lanai are not connected to the Lanai WWRF. Table 11 and Chart 5 provide projected wastewater flows to the Lanai WWRF to year 2020. Based on the projections, the Lanai WWRF has adequate capacity through year 2020.

**TABLE 11
LANAI WASTEWATER RECLAMATION FACILITY
PROJECTED WASTEWATER FLOWS**

Year	Resident Population	Visitor Population	Total Resident Flows (mgd)	Total Visitor Flows (mgd)	Total Flows (mgd)
2005	3,432	--	0.33	--	0.33
2010	3,718	--	0.36	--	0.36
2015	4,068	--	0.40	--	0.40
2020	4,442	--	0.43	--	0.43

CHART 5
Lanai Wastewater Reclamation Facility
Historical and Projected Flows

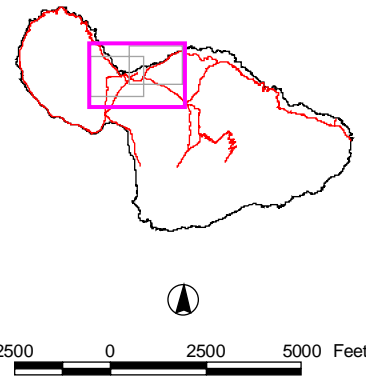


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

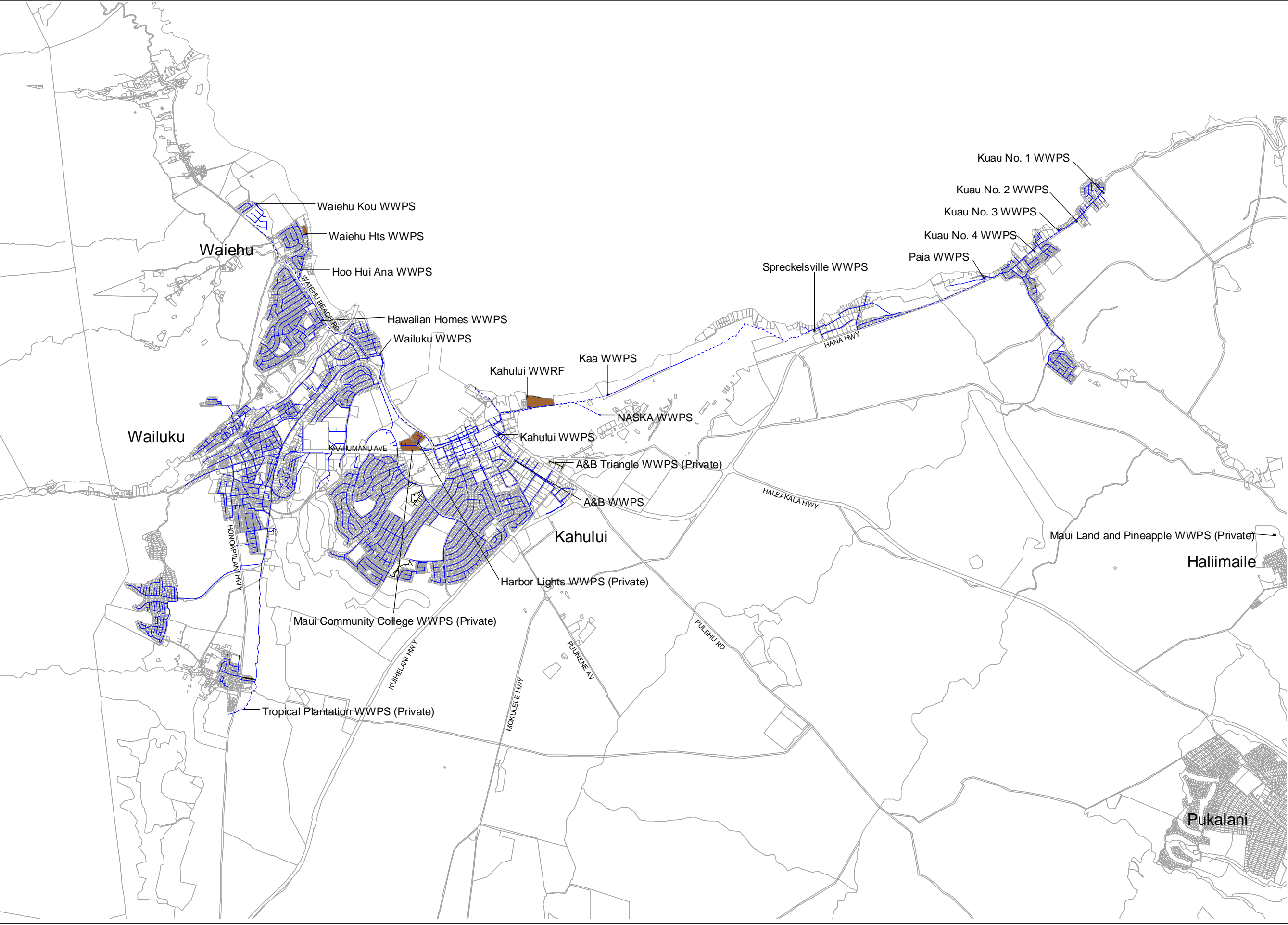
FIGURE 1
Wailuku to Paia Existing
Wastewater Collection
System

LEGEND

- Force Main
- County Sewer
- Private Sewer
- Wastewater Pump Station/Reclamation Facility



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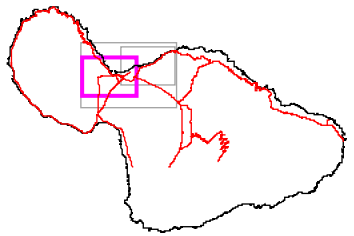


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

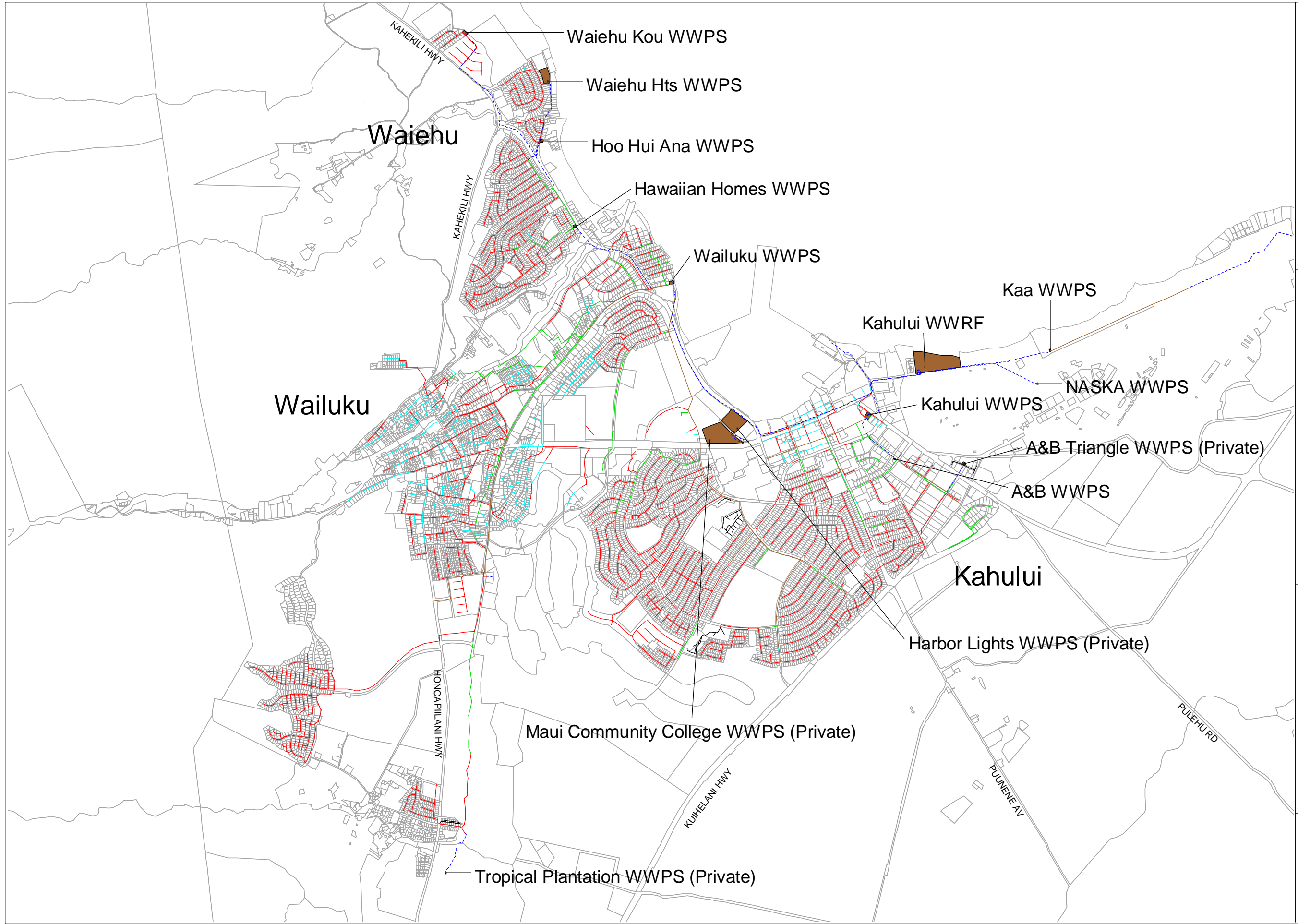
FIGURE 2
Wailuku-Kahului Existing
Wastewater Collection
System

LEGEND

- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
 - Force Main
 - Private Sewer
 - Wastewater Pump Station/Reclamation Facility



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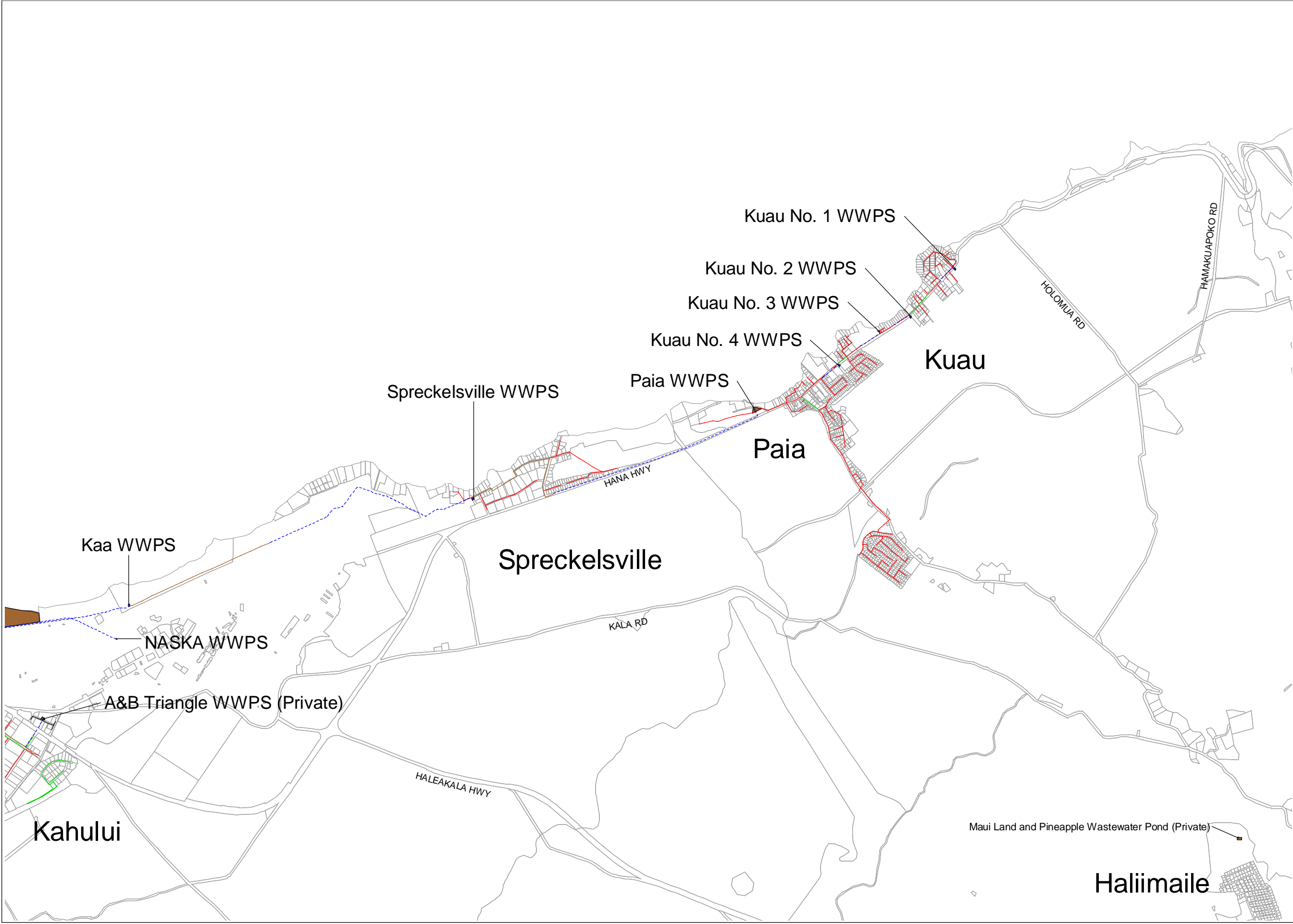
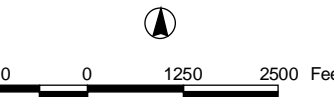
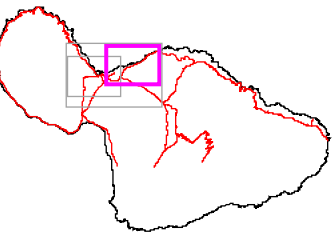


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 3
Spreckelsville-Kuau
Existing Wastewater
Collection System

LEGEND

- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
 - Force Main
 - Private Sewer
 - Wastewater Pump Station/Reclamation Facility

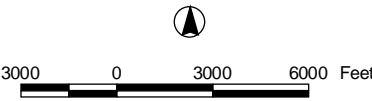
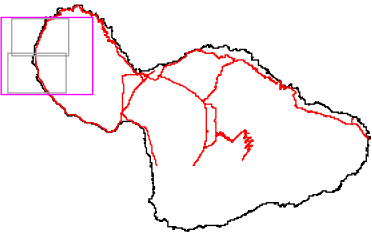


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

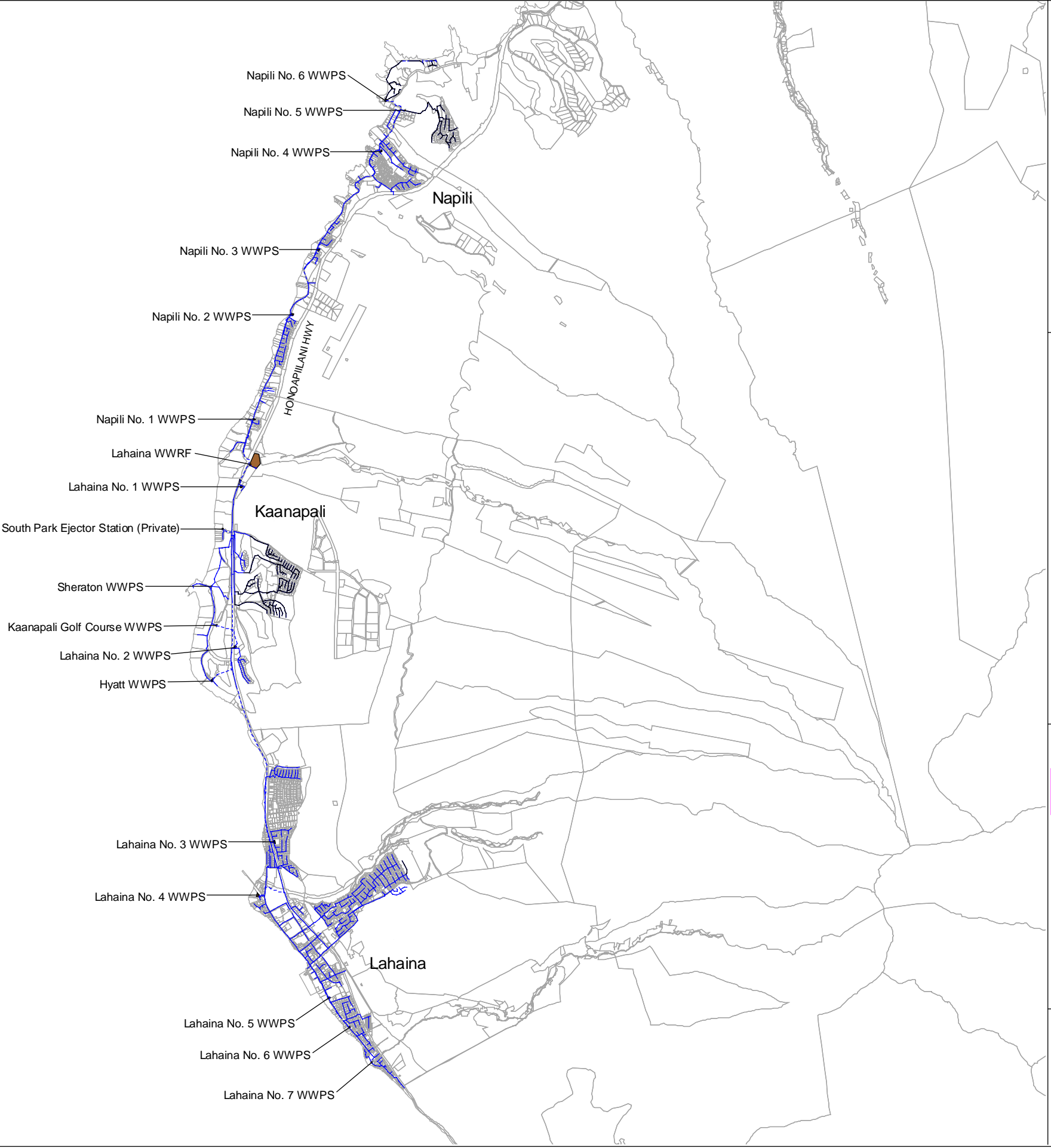
FIGURE 4
Lahaina-Napili
Existing Wastewater
Collection System

LEGEND

- Force Main
- County Sewer
- Private Sewer
- Wastewater Pump Station/Reclamation Facility



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South Park Ejector Station (Private)

Sheraton WWPS

Kaanapali Golf Course WWPS

Lahaina No. 2 WWPS

Hyatt WWPS

Kaanapali

HONOPIANI HWY

Lahaina No. 3 WWPS

Lahaina No. 4 WWPS

Lahaina

Lahaina No. 5 WWPS

Lahaina No. 6 WWPS

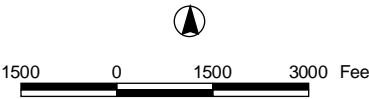
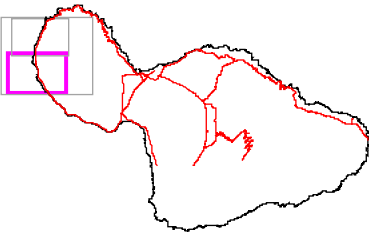
Lahaina No. 7 WWPS

MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 5
Lahaina-Kaanapali
Existing Wastewater
Collection System

LEGEND








- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
- Force Main
- Private Sewer
- Wastewater Pump Station/Reclamation Facility

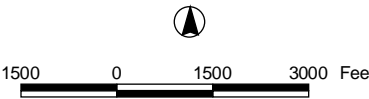
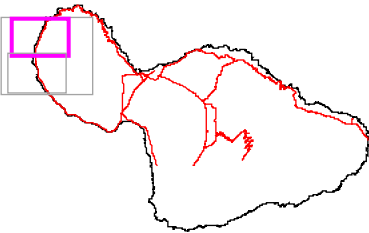


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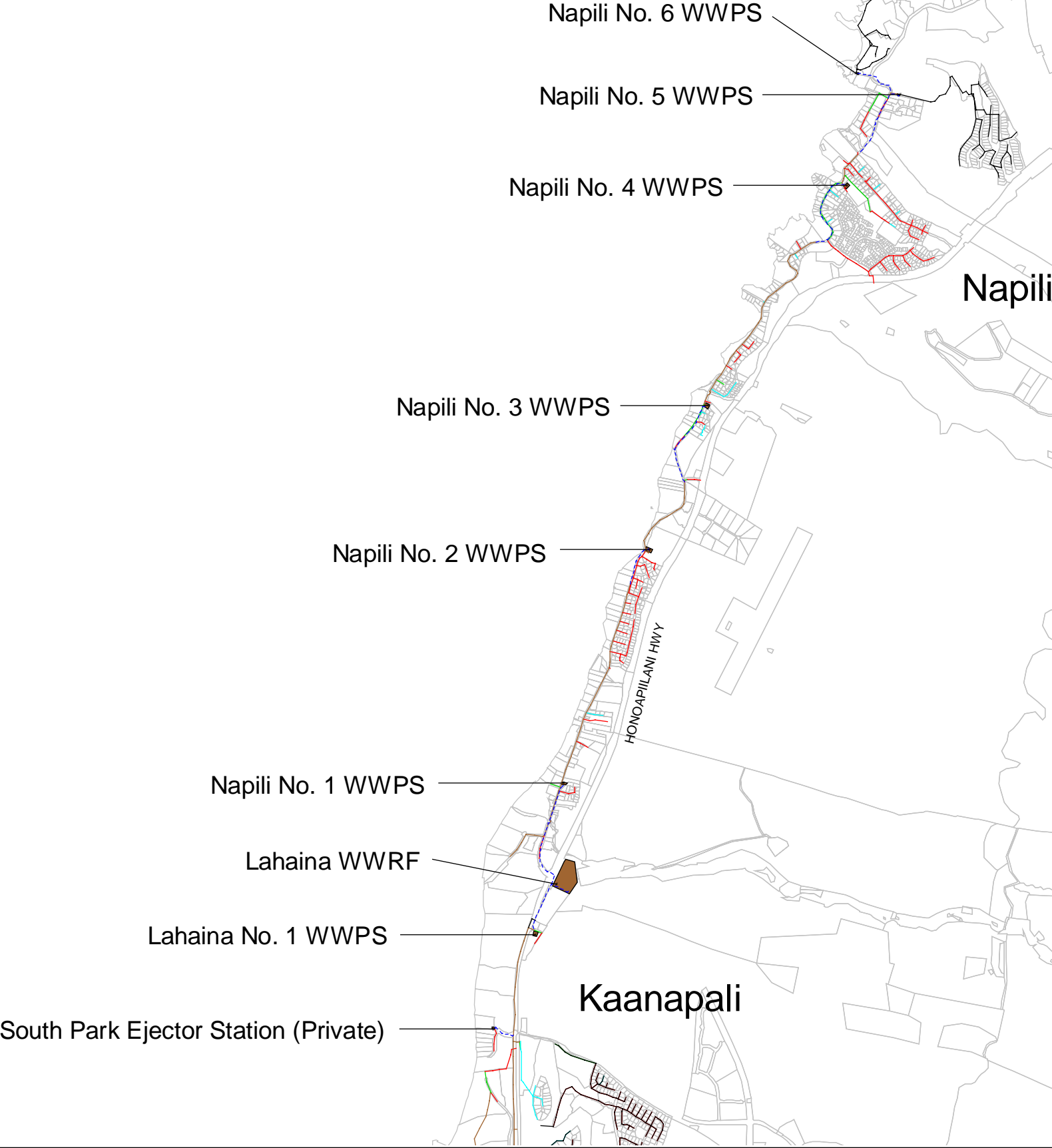
FIGURE 6
Napili
Existing Wastewater
Collection System

LEGEND

Pipe Diameter	
	6-inch
	8-inch
	10 to 12-inch
	>15-inch
	Force Main
	Private Sewer
	Wastewater Pump Station/Reclamation Facility



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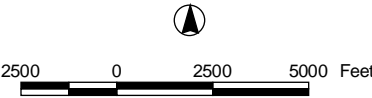
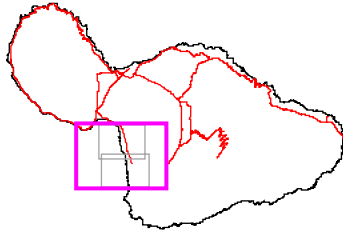


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 7
Kihei-Wailea Existing
Wastewater Collection
System

LEGEND

- Force Main
- County Sewer
- Private Sewer
- Wastewater Pump Station/Reclamation Facility



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Kihei No. 2 WWPS

Kihei No. 3 WWPS

Kihei No. 4 WWPS

Kihei No. 5 WWPS

Kihei No. 6 WWPS

Kihei No. 7 WWPS

Kihei No. 8 WWPS

Kihei No. 9 WWPS

Kihei No. 10 WWPS

Kihei No. 16 WWPS "Makena Surf"

Kihei

Tech Park No. 1 WWPS (Private)

Tech Park No. 2 WWPS (Private)

Kihei WWRF

Wailea

Makena

PULANI HWY

LIPOA ST

WELAKAHAO RD

AUHANUA RD

KANAKAULI RD

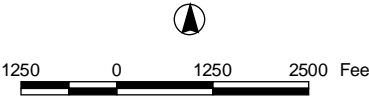
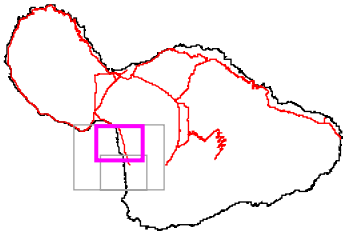
PULANI HWY

MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 8
Kihei-Wailea Existing
Wastewater Collection
System

LEGEND

- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
- Force Main
- Private Sewer
- Wastewater Pump Station/Reclamation Facility



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Kihei No. 2 WWPS

Kihei No. 3 WWPS

Kihei No. 4 WWPS

Kihei No. 5 WWPS

Kihei No. 6 WWPS

Kihei No. 7 WWPS

Kihei

LIPOA ST

PILANI HWY

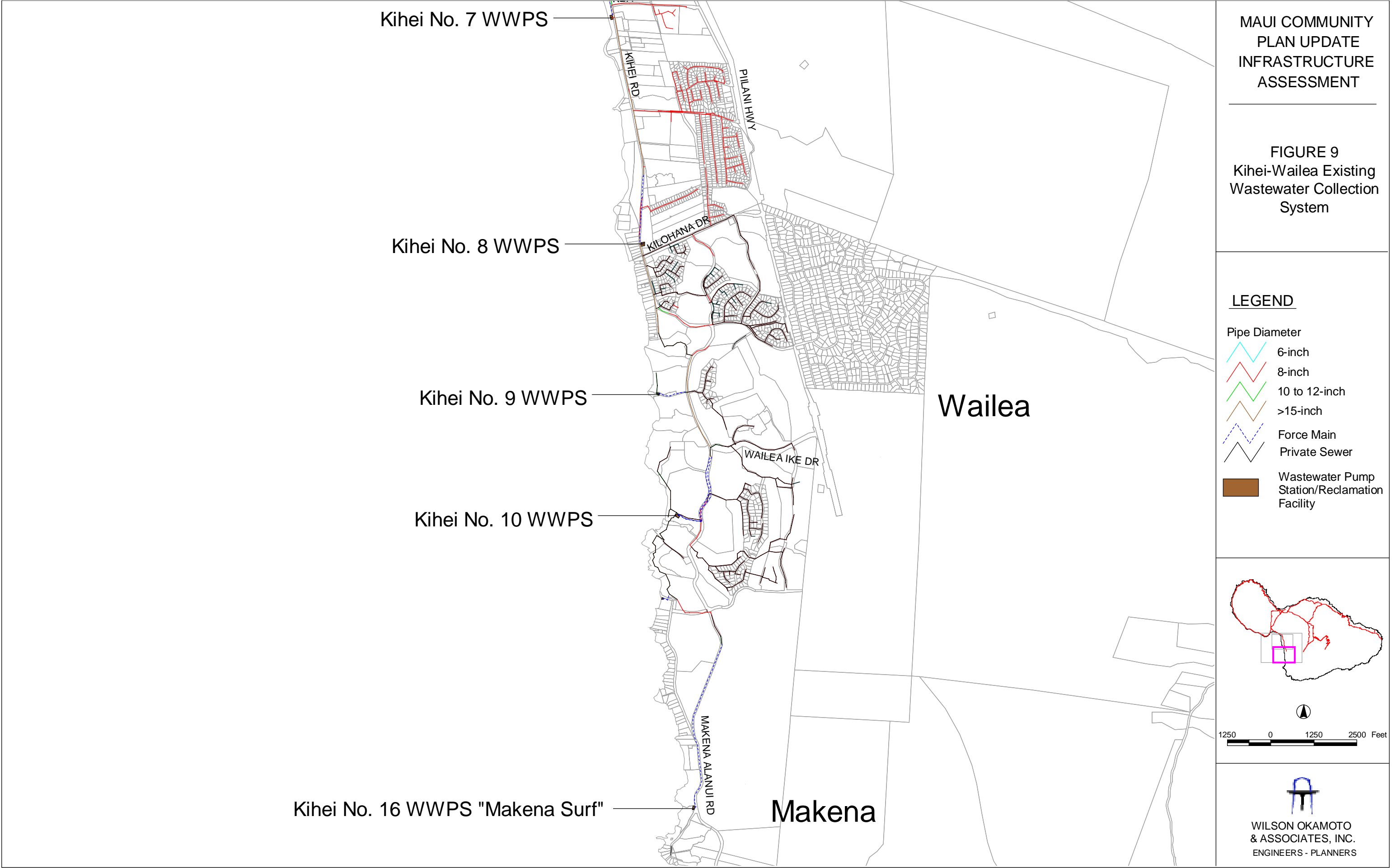
KEALII ALA NUI PL

KIHEI

Tech Park No. 1 WWPS (Private)

Tech Park No. 2 WWPS (Private)

Kihei WWRF

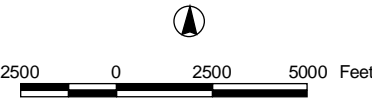
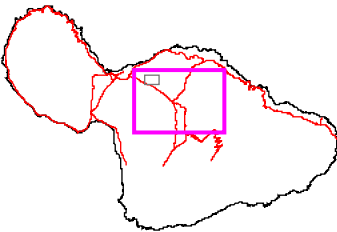


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 10
Haliimaile-Pukalani
Existing Wastewater
Collection System

LEGEND

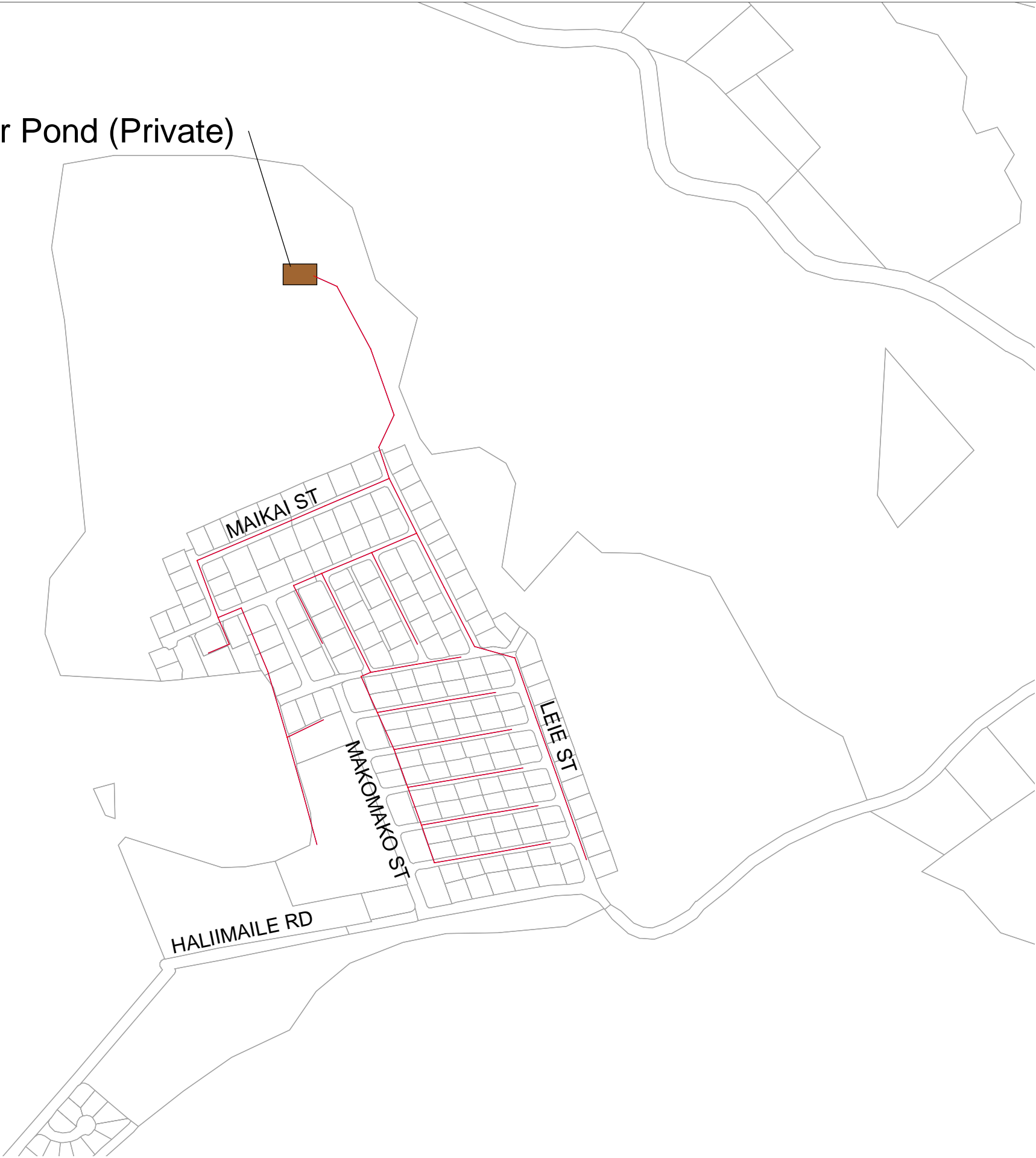
- Force Main
- County Sewer
- Private Sewer
- Wastewater Pump Station/Reclamation Facility



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Maui Land and Pineapple Wastewater Pond (Private)

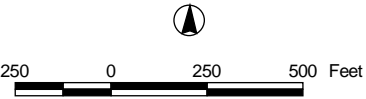
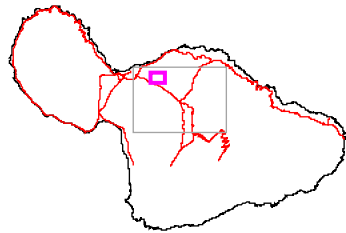


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 11
Halimaile Existing
Wastewater Collection
System

LEGEND

- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
- Force Main
- Private Sewer
- Wastewater Pump
Station/Reclamation
Facility



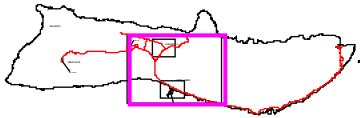
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MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 12
Molokai
Existing Wastewater
Collection System

LEGEND

- Force Main
- County Sewer
- Private Sewer
- Wastewater Pump Station/Reclamation Facility



2000 0 2000 4000 Feet

Kualapuu

Kaunakakai

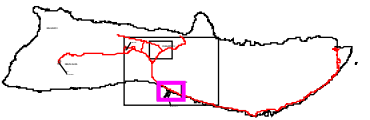
Kaunakakai WWRf

Kaunakakai WWPS

FIGURE 13
Kaunakakai
Existing Wastewater
Collection System

LEGEND

- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
 - Unknown
 - Force Main
 - Private Sewer
 - Wastewater Pump Station/Reclamation Facility



500 0 500 1000 Feet

Kaunakakai

Kaunakakai WWRF

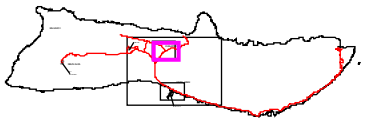
Kaunakakai WWPS

MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 14
Kualapuu
Existing Wastewater
Collection System

LEGEND

- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
 - Unknown
 - Force Main
 - Private Sewer
 - Wastewater Pump Station/Reclamation Facility



500 0 500 1000 Feet

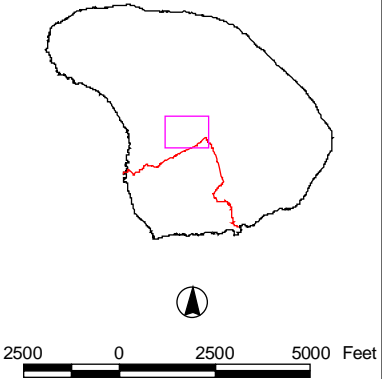


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 15
Lanai
Existing Wastewater
Collection System

LEGEND

- Force Main
- County Sewer
- Private Sewer
- Wastewater Pump Station/Reclamation Facility



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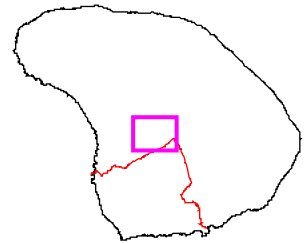


MAUI COMMUNITY
PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 16
Lanai City
Existing Wastewater
Collection System

LEGEND

- Pipe Diameter
- 6-inch
 - 8-inch
 - 10 to 12-inch
 - >15-inch
 - Force Main
 - Private Sewer
 - Wastewater Pump Station/Reclamation Facility



2500 0 2500 5000 Feet



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***County of Maui
Infrastructure Assessment Update***

Drainage Systems

Prepared for:

***County of Maui
Planning Department***

Prepared by:

Wilson Okamoto & Associates, Inc.

May 2003

TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	
I. INTRODUCTION	1
II. ASSESSMENT METHODOLOGY	2
III. WAILUKU-KAHULUI COMMUNITY PLAN REGION	3
A. Overview	3
B. Existing Drainage Deficiencies	3
C. Proposed Improvements	4
IV. KIHEI-MAKENA COMMUNITY PLAN REGION	6
A. Overview	6
B. Existing Drainage Deficiencies	6
C. Proposed Improvements	7
V. WEST MAUI COMMUNITY PLAN REGION	10
A. Overview	10
B. Existing Drainage Deficiencies	10
C. Proposed Improvements	11
VI. MAKAWAO-PUKALANI-KULA COMMUNITY PLAN REGION	13
A. Overview	13
B. Existing Drainage Deficiencies	13
C. Proposed Improvements	13
VII. PAIA-HAIKU COMMUNITY PLAN REGION	14
A. Overview	14
B. Existing Drainage Deficiencies	14
C. Proposed Improvements	14
VIII. HANA COMMUNITY PLAN REGION	16
A. Overview	16
B. Existing Drainage Deficiencies	16
C. Proposed Improvements	16
IX. MOLOKAI COMMUNITY PLAN REGION	18
A. Overview	18
B. Existing Drainage Deficiencies	18
C. Proposed Improvements	22
X. LANAI COMMUNITY PLAN REGION	24
A. Overview	24
B. Existing Drainage Deficiencies	24
C. Proposed Improvements	24
XI. REFERENCES	26

EXECUTIVE SUMMARY

A. Introduction

This *Maui Infrastructure Assessment Update* on the existing *Drainage Systems* assesses the major existing drainage systems, identifies the major problem areas of the existing drainage systems, and discusses proposed improvements for the community plan regions. The community plan regions are identified as Wailuku-Kahului, Kihei-Makena, West Maui, Makawao-Pukalani-Kula, Paia-Haiku, Hana, Molokai and Lanai.

Drainage generally refers to the system that transports rainfall and storm water runoff to waterways or bodies of water. Drainage problems occur as a result of development or the alteration of natural areas and drainage patterns. The geology of an area and rainfall patterns are also considerable factors that impact the efficiency of a drainage system.

Stream channel overflow, overland flow, and standing water in poorly drained areas are some examples of typical drainage problems. Most drainage and flooding problems occur in low-lying areas that have been developed without adequate storm drainage systems. Drainage improvements are required of new developments to ensure that the proposed development will not increase flooding of lower-lying areas.

B. Wailuku-Kahului

The Iao Stream is the major source of flooding problems in the Wailuku-Kahului area. The steep incline causes the stream flow to have a high velocity and a large volume, which causes considerable property damage and loss of life. Inadequate storm drainage facilities and the inability of local dry wells to accommodate the overtopping of gulches and ditches in Kahului causes flooding that inundates streets and low-lying residential areas. The following measures are proposed to increase the capacity of the existing system and resolve flooding and ponding problems.

- Drainage improvements through the Maui Community College campus and nearby streets
- Construction of an outlet, drainage channels, and box culverts at Amala Place
- Outlet, drainage channel and road widening improvements
- Install drainlines and a new outlet along Kahului Beach Road and Kane Street

C. Kihei-Makena

The direct cause of flooding in the Kihei area is due to the inadequate capacity of existing channels and the poorly maintained outlets to the sea. Intermittent rainfall and minimal runoff create unstable channels that are generally narrow and poorly defined. The condition of the channels makes streams susceptible to overflowing, and contributes heavily to flash flooding. The existing drainage system's facilities do not have the capacity to adequately accommodate the volume of surface runoff caused by severe storms. The following is a list of recommendations that will help to control flooding and increase drainageway capacities.

Waiakoa District:

- Maintain the present flow pattern
- Develop a flow channel
- Relegate Kihei Road to a minor gulch crossing
- Add a major crossing connecting Kenolio Road with Mokulele Highway
- Provide a storm drain/catch basin system
- Construct a sediment/equalization basin
- Install culverts/crossings

Kulanihakoi District:

- Drainage system for the Maui Lu Hotel
- Drainage system along South Kihei Road
- Construct a diversion ditch to alter flow patterns of Piilani Basins
- Construct a drainage channel from Piilani Highway to the ocean
- Construct a bridge across South Kihei Road in the vicinity of Kaonoulu Street

Waipuilani District:

- Divert a portion of the Waipuilani drainage basin to Kulanihakoi Gulch
- Improve Waipuilani channel

Keokea District:

- Allow storm discharge to flow into the wetland area
- Construct an open channel from South Kihei Road to Waipuilani Road
- Add drainage channels and culvert crossings to expand St. Theresa's regulation reservoir

Charlie Young District:

- Route the basin through existing channels and culverts by improving existing channels and the Malama Road crossing and providing a drainage system
- Build a detention/sedimentation basin mauka of the proposed North-South Collector Road and mauka of the Kanani/Kanoe Street intersection
- Replace the culverts crossing Alaloa Road
- Construct a storm drain inlet makai of Peke Place
- Include a predischage sedimentation basin at the Kalama Park Channel
- Install a drainage system along Auhana Road
- Divert the Charlie Young Gulch immediately makai of Piilani Highway
- Install box culverts at the Charlie Young/Auhana Road crossing
- Construct a channel between Auhana Road and Kanoe Street
- Replace box culverts at the mouth of the Charlie Young Gulch
- Develop a drainage system along Kanani Road

Kamaole District:

- Construct a channel to divert water north to Kamaole Gulch
- Increase the culvert size across Kanakanui Road
- Construct a drainage ditch along the southern periphery of the Maui Coast Hotel
- Increase the culvert size of Kamaole Gulch across South Kihei Road

- Increase the capacity of the two culverts on Kananakui Road
- Increase the size of the culvert at the mauka end of the Kihei Kainani parking lot
- Increase the capacity of the drainage crossing at South Kihei Road

Liholiho District:

- Install a box culvert under Kananakui Road
- Construct an enlarged crossing across Liholiho Gulch at South Kihei Road
- Install culverts across South Kihei Road
- Construct a drainage system with the development of TMK: 3-9-04:79 to include a drainage crossing at South Kihei Road

Kilohana District:

- Install five (5) culverts under Kilohana Drive
- Construct a drainage system for the Kilohana Basin

D. West Maui

There are two major watershed areas in West Maui, the Lahaina Watershed and the Honolua Watershed. There are no streams or large defined drainageways within the Lahaina Watershed. Lahaina Town consists of short, small capacity culverts with grated inlets along roadsides that outlet to the ocean. Flooding usually occurs during intense storms, which bring heavy rains of short duration. The Honolua Watershed includes numerous narrow, winding channels that drain into the ocean. Intense local rainfall causes overland flooding, sheet erosion and sediment pollution of coastal waters. Proposed drainage system improvements are to:

- Construct Drainline F across Malu-ulu-o-lele Park and Kamehameha School
- Install drainlines on Lahainaluna Road, Luakini Street and Panaewa Place
- Construct new drainage systems in roadways where there are no existing drainlines
- Upgrade existing drainlines on Baker, Papalua, Dickenson, Prison, Wainee and Front Streets

E. Makawao-Pukalani-Kula

Generally the Upcountry area does not have any major drainage or flooding problems, except in Makawao. Makawao has been subject to flooding because of sheet flow over the highlands and small culverts that are unable to accommodate the runoff. In the past, homes have experienced minor water damage while flooding has inundated yards and lawns. Although culverts crossing roads have been improved, a drainage improvements project is planned along Pahala Street, incorporating 36-inch to 54-inch drainlines that will lead to an existing channel across Maha Road.

F. Paia-Haiku

Paia and Haiku are characterized by numerous gulches and intermittent streams. Heavy rainfall causes severe soil erosion, which in turn causes soil and silt to deposit in the lower

areas. Irrigation channels overtop during flooding and cause normal to severe damage to newly planted fields and roadways. Additionally, the drainage system in the region consists only of road culverts. In order to remedy the existing problematic conditions, the following recommendations are proposed:

- Provide a system of culverts and drainage ditches to divert storm runoff
- Install a culvert at the plantation road (South of Baldwin Avenue, East of Paia School)
- Construct a lined channel north of Paia School
- Construct a lined ditch to divert the flow from lower Paia
- Construct a culvert to relieve the flow across Hana Highway
- Construct an additional lined channel to transport stream runoff from above Hana Highway

G. Hana

Flooding conditions in the past have caused portions of the stream lining to deteriorate and wash downstream. Inadequately sized drainage ditches have also caused sheet flows overtop the roadway. Additionally, floods have damaged road shoulders, retaining walls, and pavement. Sheet flow can be collected and diverted using the following recommendations:

- Improve the existing diversion channel
- Build an unlined diversion ditch north of Kawaipapa Stream

H. Molokai

The business areas of Kaunakakai town have experienced flooding due to inadequate or nonexistent drainage systems, inadequate drainageways to convey the runoff from existing systems in the upper portion of the town to the ocean, poorly drained soils in low-lying areas, and flat terrain. Poorly maintained ditches, levees, grassed swales, berms, roadway culverts, catch basins, and drainlines also contribute to flooding by reducing the carrying capacity of the drainage systems while poor grading of culverts causes ponding in low-lying areas. The portion of Kamehameha Highway that intersects Kaunakakai Stream is serviced by a stream ford that provides inadequate access to emergency vehicles in times of high stream flow. A system has been proposed to accommodate future development and is divided into five separate sub-systems.

- **System A:** A berm/grassed ditch would tie into the existing U.S. Army Corps of Engineers levee and serve as a diversion for runoff generated by the town's center.
- **System B:** A combination of box culvert/grade inlet and open channel systems will drain the center of the business district, the County storage yard, and land directly East of Kaunakakai Place.
- **System C:** A combination of box culvert/grade inlet and open channel systems will drain the southeast portion of the business district and related parcels.
- **System D:** Concrete lined channels will drain runoff generated from portions of the town's subdivisions and serve as a collection channel for runoff for adjacent

parcels.

- **System E:** Two concrete lined channels will run from Kamehameha Highway to the ocean, a new channel will replace an existing ditch and install new box culverts.
- **Future Development:** The County should adopt and enforce policies that minimize adverse effects due to future development.
- **Maintenance Program:** The County should institute a regular inspection and maintenance program for the drainage system.
- **Flood Control:** The County should pursue the use of a diversion berm/flood control channel to convey flow.
- **Kamehameha Highway:** A new bridge will allow free travel across the stream during flood conditions.

I. Lanai

The lack of definitive streams flowing throughout the island and the differing ground slope of individual basins makes it difficult to define drainage basins on Lanai. However, there is a relatively good drainage pattern around Lanai City as its slope and terrain provide for natural drainage. Deep gulches also provide the carrying capacity necessary to manage increased runoff.

While drainage patterns are good, there are recommendations that will further improve drainage systems. They are to:

- Use drainlines to collect storm runoff in the mauka area of the gulch and discharge it into an existing golf course lake.
- Direct the flow of storm runoff from other areas of the gulch to existing retention basins and then to existing drain lines for ultimate discharge into Kaiholena Gulch.
- Collect storm runoff from the adjacent gulch area in the proposed drainage system and discharge it by two 72-inch drain pipes into Kapono Gulch.

I. INTRODUCTION

This section presents an assessment of major existing drainage systems in the community plan regions of Wailuku-Kahului, Kihei-Makena, West Maui, Makawao-Pukalani-Kula, Paia-Haiku, Hana, Molokai, and Lanai. The emphasis of this assessment is on describing the major problem areas of existing drainage systems that result in periodic flooding.

In the County of Maui, the Department of Public Works, Engineering Division, is responsible for overseeing drainage systems and improvements. Federal agencies are also directly involved in drainage projects, including the U.S. Department of Agriculture Natural Resources Conservation Service and the U.S. Army Corps of Engineers (COE).

Drainage generally refers to the system for the conveyance of rainfall and storm water runoff to waterways or bodies of water. Drainage presents itself as a problem in the form of flooding due to the development or alteration of natural areas and drainage patterns. Geology and rainfall are the major influences on drainage systems. Runoff is a function of infiltration capacity (soil type), relief, vegetal cover, and development type.

The Island of Maui is formed by the two volcanic cones of Haleakala on East Maui and Puu Kukui on West Maui. The two cones are joined by a relatively flat isthmus, formed of sand blown inland when the sea was somewhat lower during the late Pleistocene period. East Maui is geologically younger than West Maui, as evidenced by the absence of deeply incised canyons and extensive areas of volcanic lava and cinders on the leeward slopes of Haleakala. The lands more suitable for agriculture, including the gentle slopes of central Maui and the tablelands of West Maui, resulted from alluvial deposits and the decomposition of basaltic materials.

Rainfall varies considerably from one part of the Island to another. Rainfall in the windward areas of Maui are heavier than on the leeward side. In East Maui, the highest rainfall area is on the windward side of Haleakala between the 2,000- and 4,000-foot elevations, where the median annual rainfall is 200 to 300 inches. On the western side of the Island, median annual rainfall near the summit of Puu Kukui is approximately 400 inches. In contrast, leeward locations in central Maui such as Kihei have a mean annual rainfall of 10 inches.

The Island of Molokai is formed by three volcanoes – West Molokai, East Molokai and the Kalaupapa Peninsula on the north coast of the eastern volcano. The Island is generally separated into two major parts – East and West Molokai. These massifs were built upward from the sea floor to an elevation of about 5,000 feet in East Molokai and about 1,400 feet in West Molokai. Within East Molokai, the large eastern dome is cut into great amphitheater-headed valleys on the windward side and smaller ones on the leeward side. The dome is composed chiefly of thin-bedded tholeiitic aa and pahoehoe. Most of West Molokai is covered with lateritic soil 10 to 50 feet thick, indicating long extinction. The volcano has a flatter dome than most in the Hawaiian group.

The median annual rainfall on Molokai varies with elevation from about 10 inches along the coast to about 75 inches at the upper reaches of the watershed. The rainfall is highest on the crest and windward side of East Molokai, decreasing rapidly toward the west with

an annual rainfall difference of up to 50 inches in these two areas.

The Island of Lanai consists of a single basaltic dome 3,370 feet high and about 13 miles across, with its summit collapsed and its sides greatly disturbed by faulting. Although the Island was formed by a single volcanic activity, five fairly distinct land units are recognized: 1) the Central Basin; 2) the canyon country; 3) the northwest rift zone; 4) the southwest rift zone; and 5) the faulted south rift zone. A red residual of lateritic soils covers most of the Island with a depth of approximately 50 feet at elevations above 1,200 feet.

Median annual rainfall on Lanai at elevations below 2,500 feet ranges from less than 10 inches to as high as 25 inches. At elevations above 2,500 feet, median annual rainfall is approximately 35 to 40 inches.

II. ASSESSMENT METHODOLOGY

Drainage problems in Maui are related to channel overflow, overland flow, and standing water in poorly drained areas. Stream channel overflow is mainly due to the high frequency of intense rainfall. Flooding is caused by fast-moving surface runoff from steep mountain slopes discharging onto low, flat coastal plains. Most drainage and flood problems on the Island occur in low-lying areas which have been developed without adequate storm drainage systems.

The current assessment of drainage systems focuses on existing problem areas. The assessment updates the County of Maui Planning Department's *Maui Community Plan Infrastructure Assessment* (September 1992) and also includes the community plan regions of Paia-Haiku, Hana, Molokai, and Lanai. Existing drainage system information for these four community plan regions were derived in part from the *Drainage Master Plan for the County of Maui* (October 1971) and the County of Maui Department of Public Works' *Drainage Master Plan for Kaunakakai, Molokai, Hawaii* (August 1992). Updated information on the existing drainage systems and problem areas for the entire County of Maui were then obtained from discussions with the County's Department of Public Works staff.

The drainage improvements are intended to remedy problems being experienced in already developed areas.

In undeveloped areas, proposed developments undergo review by the Department of Public Works for potential drainage or flood hazard concerns. Typically, developers are required to prepare a drainage plan showing on-site and off-site storm runoff conditions, rainfall intensity and size of drainage area, and proposed improvements to accommodate peak storm discharges. Drainage improvements are required to assure that the proposed development will not increase flooding of lower-lying areas.

III. WAILUKU-KAHULUI COMMUNITY PLAN REGION

A. Overview

The Wailuku-Kahului region is situated on the northern section of the isthmus linking Haleakala and the West Maui Volcano. The Wailuku area is primarily on the eastern slopes of the West Maui Mountains, while Kahului lies in sand dunes which are typical of much of the low-lying central isthmus. Elevation ranges from a few feet above sea level in the Paukukalo area to about 500 feet at the Iao Valley Road junction.

The natural boundary between the alluvial soil of most of Wailuku and the sand dunes of the eastern section is Waiale Drive and East Main Street. Typical contours west of Waiale Drive run mainly in a north-south direction with a general slope downward from west to east of about 5 to 7 percent. Contours of the sand dune area follow no definite pattern and there are much more decided ridges and low spots, and no marked natural drainage pattern.

Major drainageways for the Wailuku-Kahului region are presented in Figure 1.

B. Existing Drainage Deficiencies

Historically, the major flood problem in the Wailuku-Kahului area has been caused by Iao Stream. The drainage area contributing to the stream development comprises 8.2 square miles. The lower reaches of the Iao Stream are on a broad plain that extend to the ocean. Iao Stream is perennial from its source to the vicinity of the Waihee Ditch and, from that point, is intermittent to the ocean. Due to the steep ground gradient, flood problems caused by high velocity and large quantity of flow have caused considerable property damage and loss of life. In 1977, the COE completed major channel improvements in Iao Stream from the vicinity of the Market Street Bridge to Wailuku Sugar Mill and Waiehu Beach Road to the ocean, and construction of a debris basin one mile upstream from the Bridge. Presently, the COE is planning to improve Iao Stream between Wailuku Sugar Mill and Waiehu Beach Road within the next five years.

The secondary areas of flooding of the Wailuku-Kahului area are the low-lying sections of Kahului. Flooding primarily consists of inundation of the streets and low-lying residential areas. Such flooding is caused by the lack of adequate storm drainage facilities, and the inability of local dry wells to accommodate the overtopping of gulches and ditches.

Major problem areas in Kahului include the intersection of Hana Highway and Dairy Road, Puunene Avenue from the Wakea Street intersection to the Kaahumanu Avenue intersection, and Kaahumanu Avenue at the Kaahumanu Center intersection. Many of the streets within the older residential areas do not have drainage systems and are subject to localized flooding at low points where runoff collects. Although the County has installed dry wells (typically a pit with a grated inlet on a concrete box with an open bottom) along many of the low-lying streets, these areas continue to flood during severe storms due to lack of sufficient capacity or clogging of the dry wells (*Kahului Drainage Master Plan*, 1991).

One of the most severe problem areas is in the Sixth Increment Subdivision (bounded by Kaahumanu, Wakea, Onehee, and Papa Avenues) within a large depression along Maalo Street, Ohaa Street, and Aleo Place. Severe flooding occurs within the Aleo Place cul-de-sac when the sumps along Maalo Street and Ohaa Street become filled, resulting in runoff to flow into Aleo Place. Runoff from the subdivision also causes flooding along Kaahumanu Avenue at the entrance to Kaahumanu Center since the existing drainage system is unable to accommodate the runoff.

Similarly, flooding along lower-lying areas on Puunene Avenue and Kamehameha Avenue occurs since most of the surrounding residential streets lack drainage systems. Other problem areas include low-lying areas along Hobron Avenue and Amala Place in the harbor industrial area, and the potentially limited capacity of the drainage sump at the Kahului Community Center.

Drainage improvements for Waiale Road between Wells Street and Makahala Place (72-inch and 60-inch lines) with additional drain lines along portions of Makahala Place, Kaohu Street and Pikale Place were completed in 1993.

Drainage improvements for the Maui Lani Project District consist of retention basins and an injection well system within the golf course. Runoff from residential and commercial areas is conveyed to the retention basins. Off-site runoff is directed at the project's western boundaries by a system of ditches and berms into the retention basins.

In the Wailuku District Development, an on-site detention basin makai of Kama Ditch temporarily stores peak flows for subsequent discharge to the County's drainage system at Waiale Road/Wells Street.

C. Proposed Improvements

The *Kahului Drainage Master Plan* proposes drainage improvements in five major phases to address the localized flooding problems arising from inadequate drainage systems. The proposed drainage improvements are depicted in Figure 1.

Phase 1: Drainage improvements would be provided through the Maui Community College campus, along Wakea Avenue, with a branch extending along Kea Street, Kaao Circle, Ohaa Street, and ending at Maalo Street. The system outlets into a sump makai of the Maui Community College campus, then into Kahului Harbor.

These improvements will resolve flooding along Kaahumanu Avenue at the entrance to Kaahumanu Center, as well as flooding along Maalo Street, Ohaa Street, and Aleo Place. Collecting runoff from Maalo and Ohaa Streets will prevent flooding of the Aleo Place cul-de-sac. Estimated cost: \$9.7 million.

Phase 2: Drainage improvements would be provided to resolve flooding of low-lying areas along Hobron Avenue and Amala Place, including construction of an outlet, drainage channels, and box culverts at Amala Place. Estimated cost: \$9.6 million.

Phase 3: Initiation of drainage improvements along portions of the Puunene Avenue and Kamehameha Avenue systems, including an outlet, drainage channel and road widening. Estimated cost: \$14.9 million.

Phase 4: Drainlines along Kahului Beach Road and Kane Street and a new outlet to increase capacity of the existing system and support improvements along Kamehameha Avenue and Wakea Avenue. Estimated cost: \$4.6 million.

Phase 5: Continuation of Phases 3 and 4 drainage and road widening improvements along Wakea Avenue and Kamehameha Avenue. The improvements will resolve ponding problems on Wakea Avenue and Kamehameha Avenue, and provide an overflow outlet for the Kahului Community Center drainage sump. Estimated cost: \$8.0 million.

The *Report of Storm Drainage Study for Wailuku* of 1964 which made extensive recommendations for drainage system improvements in the Wailuku Town area continues to serve as the guide for improvements and is still in the process of being implemented. It is noted, however, that a major portion of the drainage improvements have been completed.

For the Wailuku Project District development, two storm water detention basins will be constructed to reduce peak surface runoff volumes in existing natural drainageways. Mauka of the existing Kama Ditch, runoff will be conveyed through open channels and underground drainage systems to a new detention basin adjacent to the existing Punawai reservoir in Waikapu makai of Honoapiilani Highway.

IV. KIHAI-MAKENA COMMUNITY PLAN REGION

A. Overview

The Kihei watershed is located on the western slope of Mount Haleakala on a curved band that extends approximately 8 miles south from Mokulele Junction to Wailea and approximately 15 miles east from the shore to the summit of Haleakala. The coastal area is relatively dry with a mean annual rainfall of 10 inches. The predominant features of the Kihei area include sandy beaches of varying widths along the coast and relatively flat or low-lying areas along the shore. Elevation of the lowland areas up to Kihei Road is approximately 5 to 6 feet. The mountain slopes above the Kihei coastal lowland are drained by 32 gulches, ravines, and gullies. Only seven have well defined watercourses, and even these do not maintain stabilized channels completely across the lowland area to the ocean.

Between Kihei Road and Piilani Highway, there are numerous intermittent and poorly defined gulches. Gradual slopes in this area approximate 4 to 5 percent with elevations ranging from 5 to 90 feet. These slopes establish little or no well-defined surface drainage pattern.

The three principal streams in the area which flow westward and seaward only during periods of excessive rainfall are Kulanihakoi, Waipuilani and Keokea Streams. They are narrow and poorly defined waterways. Localized depressions, ponds, swales and ditches are typical of areas along Kihei Road.

Major drainageways for the Kihei-Makena region are presented in Figures 2 to 5.

B. Existing Drainage Deficiencies

The direct cause of flooding in the Kihei area is the inadequate capacity of existing channels. Storm runoff flows at high velocities above the coastal plain due to the steep ground gradient at upper elevations. As the floodwaters approach the coastline, ponding occurs due to inadequate outlets to the sea which are frequently plugged with ocean-deposited sand.

Four gulches, Waiakoa, Kulanihakoi, Waipuilani and Keokea Gulches, flow in an east-to-west direction and drain approximately 65 percent of the watershed. The drainageways do not maintain stabilized channels and are generally narrow and poorly defined due to intermittent rainfall and minimal runoff throughout most of the year. The gulches are normally dry, flowing only during periods of excessive rainfall. The streams are susceptible to overflowing and contribute heavily to flash flooding in the Kihei drainage basin during storms or heavy rains.

The high volumes and velocities of the flood waters of these streams, on their approach to the Kihei flood plain, result in the overtopping of existing drainage structures crossing Kihei Road. This flat low-lying coastal area is the recipient of all this surface runoff and contributes to the flood problems in the Kihei area.

The existing drainage system consists of drainage facilities with capacities which are inadequate for the volume of surface runoff generated by severe storms. In the area from Kapuna Street to Alahele Place, inadequate drainage results in sheet flow runoffs down to Kihei Road. This runoff either ponds along Kihei Road or sheet flows across Kihei Road to the lower-lying areas. Two existing grated catch basins (located at the Keala Place/Kihei Road intersection and at the adjacent entrance to the Foodland parking area) with 18-inch diameter culverts collect and direct runoff across Kihei Road to the existing unlined channel in Kalama Park. The Kalama Park channel flows into the ocean approximately 700 feet from Kihei Road. Problems have also occurred on Lipoa Street, resulting in the flooding of adjacent residences.

In the area from Welakahao Road to Kapu Place, the runoff is collected in a series of concrete-lined and unlined channels located mauka of Kihei Road. Runoff is then diverted across Kihei Road by a concrete box culvert and flows to the ocean in the existing drainage channel. The drainage channel, located between Kapu Place and Lipoa Street, flows into the ocean approximately 900 feet from Kihei Road.

A box drain system along Welakahao Road has been constructed to improve the drainage system.

C. Proposed Improvements

To control flooding and increase drainageway capacities, a number of studies have proposed improvements to the Kihei area through channelization of the major gulches -- Kulanihakoi, Waipuilani, and Keokea. The flood control program basically involved lining the streams and installing lateral interception ditches to collect sheet flow. The Corps of Engineers efforts to provide flood control projects failed to meet their cost-benefit analysis, with the projected cost of improvements exceeding the potential benefits to be derived from prevention of damages to structures and property.

As Kihei has experienced considerable rapid growth and development since the previous drainage studies were completed, the County of Maui Department of Public Works prepared a *Drainage Master Plan for Kihei, Maui, Hawaii* (September 1994, Draft). The study area spans from North Kihei Road to Kilohana Drive, mauka and makai of Piilani Highway, and is divided into eight (8) districts corresponding to the major gulches and adjacent drainage basins. Potential drainage system improvements are recommended for the various gulches and basins within each district. The proposed drainage improvements are depicted in Figures 2 through 4.

Waiakoa District: The Waiakoa District encompasses the area between the Piilani Highway/South Kihei Road intersection to the area just south of Ohukai Road. Recommended improvements include maintaining the present flow pattern mauka of Piilani Highway; developing a flow channel of 7,700 cfs capacity for development from Piilani Highway to Kihei Road; relegating Kihei Road to a minor gulch crossing and adding a major crossing connecting Kenolio Road with Mokulele Highway; constructing a concrete channel from Kihei Road to the ocean; providing a storm drain/catch basin system

along the north side of Uwapo Road upon construction of the road; constructing a sediment/equalization basin immediately makai of Piilani Highway; installing culverts across Kaiola Place; including a flow channel with development of Tax Map Keys (TMKs): 3-9-35: 1 and 2; constructing a storm drain inlet/catchment basin on the mauka edge of Kenolio Road; establishing a catch basin mauka of the Kenolio Street/Konale Street intersection; constructing a sedimentation basin immediately mauka of Piilani Highway near Palanehe Street; constructing a Kaiola Place culvert/crossing; and, constructing an Ohukai Road storm drain from Kaiola Place to the ocean.

Kulanihakoi District: The Kulanihakoi District spans the area from just south of Ohukai Road to the area just south of Kulanihakoi Road. Recommended improvements include a drainage system for the Maui Lu Hotel and along South Kihei Road south of Kulanihakoi Gulch; construction of a diversion ditch to alter flow patterns of Piilani Basins 9 and 10 mauka of Piilani Highway to be directed to Kulanihakoi Gulch; and, construction of a drainage channel from Piilani Highway to the ocean in the vicinity south of Kaonoulu Street, with a bridge across South Kihei Road to allow flow to pass through during high tide.

Waipuilani District: The Waipuilani District encompasses the area from just south of Kulanihakoi Road to Namauu Place. Recommended improvements include diverting a portion of the Waipuilani drainage basin to Kulanihakoi Gulch and improving Waipuilani Gulch channel.

Keokea District: The Keokea District spans the area from Namauu Place to just south of Uilani Street/Waipaha Street. Recommended improvements include allowing storm discharge to flow into the wetland area in the vicinity of TMK: 3-9-07: 7; constructing an open channel from South Kihei Road to Waipuilani Road; and, expanding St. Theresa's regulation reservoir through construction of additional drainage channels and culvert crossings and which would involve wetland areas.

Charlie Young District: The Charlie Young District encompasses the area from just south of Uilani Street/Waipaha Street to the area just south of Walaka Street. Recommended improvements include routing Basin 17a through existing channels and culverts to immediately south of Kupuna Street, which would require improving existing channels and the Malama Road crossing and providing a drainage system from TMK: 3-9-32: 1 to the ocean through either the end of Waimahaihai Street or within Kalama Park; building a detention/sedimentation basin mauka of the proposed North-South Collector Road; replacing the culverts crossing Alaloa Road; constructing a storm drain inlet makai of Peke Place; improving the Kalama Park Channel to include a predischage sedimentation basin; installing a drainage system along Auhana Road; diverting the Charlie Young Gulch immediately makai of Piilani Highway north along Kakanui Road then west to Auhana Street; installing box culverts at the Charlie Young/Auhana Road crossing; constructing a channel between Auhana Road and Kanoe Street; building a detention/sedimentation basin mauka of the Kanani/Kanoe Street intersection; replacing box culverts at the mouth of the Charlie Young Gulch; and developing a drainage system along Kanani Road.

Kamaole District: The Kamaole District encompasses the area from just south of Walaka Street to the area north of Keonekai Road. Recommended improvements include constructing a channel to divert water north to Kamaole Gulch makai of Piilani Highway; increasing the culvert size across Kanakanui Road; constructing a drainage ditch along the southern periphery of the Maui Coast Hotel; increasing the culvert size of Kamaole Gulch across South Kihei Road; increasing the capacity of the two culverts on Kanakanui Road; increasing the size of the culvert at the mauka end of the Kihei Kainani parking lot; and, increasing the capacity of the drainage crossing at South Kihei Road from Kihei Kainani south to the existing culvert.

Liholiho District: The Liholiho District spans the area from north of Keonekai Road to just north of Kilohana Drive. Recommended improvements include installing a box culvert under Kanakanui Road; constructing an enlarged crossing across Liholiho Gulch at South Kihei Road; installing culverts across South Kihei Road; and, constructing a drainage system with the development of TMK: 3-9-04: 79 to include a drainage crossing at South Kihei Road.

Kilohana District: The Kilohana District encompasses the area from just north of Kilohana Drive to the area north of Okolani Drive in Wailea. Recommended improvements include installing five (5) culverts under Kilohana Drive to maintain the natural drainage conditions of the area; and, construction of a drainage system for the Kilohana Basin 2 which is a small, relatively undeveloped drainage area.

V. WEST MAUI COMMUNITY PLAN REGION

A. Overview

The West Maui region, which covers the entire Lahaina Judicial District, encompasses two major watershed areas --the Lahaina Watershed area and the Honolua Watershed. Major drainage improvements have been previously proposed in these watershed areas and are in various stages of implementation.

The Honolua Watershed, approximately 24,800 acres, spans the area north of the Kaanapali Resort to Honolua Bay. The upper point of the watershed is Puu Kukui, the highest peak in the West Maui mountains. The watershed is incised by deep valleys radiating outward to the ocean. Grades begin at about 16 percent and flatten to 6 percent toward the ocean. Defined channels exist in the major valleys, varying from 5 to 10 feet deep and 10 to 20 feet wide.

The Lahaina Watershed in the vicinity of Lahaina Town is approximately 4,920 acres and encompasses Lahaina Town and Puamana subdivision. The area above the developed flatland to the 1,400-foot elevation is gently sloping and was previously used for sugar cane cultivation. The abandoned sugar cane fields have an average slope of ten percent. The remaining upper area of the Lahaina subwatershed is steep and is used for pasture. The upper portion of the watershed is mountainous with deeply incised canyons and is part of the West Maui Forest Reserve.

Major drainageways for the West Maui region are presented in Figures 6 to 9.

B. Existing Drainage Deficiencies

There are no streams or large defined drainageways within the Lahaina Watershed. Runoff from above Lahaina Town is conveyed by numerous small drainageways through abandoned sugar cane fields and roads, over Honoapiilani Highway, and into Lahaina Town where it ponds in low spots or drains into the ocean. The storm drain system in Lahaina Town consists of short, small capacity culverts with grated inlets along roadsides that outlet to the ocean. Runoff ponds in the low-lying areas around Maluuluolele Park and the commercial areas along Front Street and Wainee Street (*Lahaina Watershed Plan*, 1990).

Flooding usually occurs during intense storms which bring heavy rains of short duration. Most of the existing drainage facilities in Lahaina Town were installed to discharge storm runoff from existing developments. Major drainage facilities include:

- a) 36" drain line along Baker Street;
- b) 24" and 30" drain lines in parallel along Papalua Street;
- c) 24" and 30" drain lines on Dickenson Street;
- d) 24" drain line on Prison Street; and,
- e) a combination of drain lines and open channels at Malu-ulu-o-lele Park.

North of Lahaina Town, the Kahoma Stream has historically been a major source of flooding due to its limited capacity in the lower reaches and the relatively steep slope of the stream. During the 1960 storm, 21.7 inches of rain fell in one day on the upper Kahoma basin, flooding 36 homes and making Front Street and Honoapiilani Highway impassable. The COE's Kahoma Stream Flood Control Project provided structural improvements, including a debris basin and a concrete channel that increased the capacity of storm flows through the Kahoma Stream.

The existing drain lines along Front Street have been upgraded as part of the County's *Lahaina Town Development Plan Infrastructure Master Plan (Phase II)* (1988).

The Honolua watershed includes numerous narrow winding channels that drain into the ocean. Affected developed communities in the low-lying coastal areas include Napili, Honokowai, Mahinahina, and Kaopala. Intense local rainfall causes overland flooding, sheet erosion and sediment pollution of coastal waters. Since 1955, there have been 12 damaging floods.

Drainage improvements such as desilting basins, lined channels and floodwater diversions to debris basins have been constructed within the Napili 2-3, Mahinahina and Honokowai gulches as part of the implementation of the *Honolua Watershed Plan* by the U.S. Department of Agriculture Natural Resources Conservation Service and the County of Maui. Five other basins serving only as sediment reduction structures were constructed for the Napili 4-5, Honokeana, Kaopala, Pohakukaanapali, and Kahana gulches.

C. Proposed Improvements

Major drainage improvements have been proposed or are being undertaken in the watershed areas. In the Lahaina watershed, plans by the U.S. Department of Agriculture Natural Resources Conservation Service call for the installation of a 6,831-foot floodwater diversion channel that starts at Lahainaluna Road, extends across the Lahaina subwatershed mauka of Honoapiilani Highway, and outlets into Kauaula Stream (See Figure 6). Associated structures include an inlet basin, an energy dissipating basin, and three sediment basins. A debris basin would be constructed at Kauaula Stream to capture cobble to boulder-sized rocks and to divide floodwater discharge between two outlet channels. In response to community concerns, a second outlet channel would be constructed extending past the Puamana Subdivision approximately 3,600 feet to the south of Kauaula Stream, with a sediment basin, highway culvert, and ocean outfall. The project is presently undergoing its environmental assessment requirements. The improvements will provide a 100-year level of flood protection to the area. Estimated cost of the improvements is \$10.0 million.

Pending the implementation of the Lahaina watershed improvements, other proposed drainage system improvements are outlined in the *Lahaina Town Development Plan: Infrastructure Master Plan (Phase II)* (1988). Proposed drainage system improvements included the following and are depicted in Figure 6.

- 1) Construction of Drainline F across Malu-ulu-o-lele Park and Kamehameha School site to dispose of runoff from the Lahaina Town Watershed mauka

of the highway.

- 2) Installation of drainlines on Lahainaluna Road, Luakini Street and Panaewa Place, respectively. Lahainaluna Road has no existing drainage system and therefore these drainlines are critical to handle localized runoff.
- 3) Construction of new drainage systems in roadways where there are no existing drainlines.
- 4) Upgrade of existing drainlines on Baker, Papalua, Dickenson, Prison, Wainee, and Front Streets.

VI. MAKAWAO-PUKALANI-KULA COMMUNITY PLAN REGION

A. Overview

The Makawao-Pukalani-Kula region is situated on the northwest upland slopes of Mount Haleakala. Elevation ranges from approximately 800 to 10,000 feet above mean sea level. Most of the developed and agricultural areas are between 1,500 and 3,500 feet in elevation. Topography of the Upcountry Maui area is a series of broad, rolling ridge tops and deep, steep-sided gulches. Slopes increase considerably with elevation along the ridges.

The many gulches divide and separate the arable land into relatively small areas more suitable to family operations than large-scale farming as in the flat central isthmus. Major gulches in the region include Maliko, Kailua, Kaluapunani, Waiale, Kalialinui, Pulehu, Hapapa, Keahuawi, Naalae, Kaonoulu, Kaakaulua, and Waiohuli. See Figures 10 to 12.

The Haleakala dome portion, which includes the Upcountry Maui area, is composed mostly of the basalts of the older Honomanu Volcanic Series that are frequently overlain with later lavas of the Kula and Hana Series. Permeability of these series varies from the highly permeable Hana Series to the fairly permeable Kula Series.

Rainfall in the Upcountry area is greatest at about the 3,000-foot elevation along the windward slopes of Haleakala. From this elevation, rainfall decreases rapidly above and below this belt. Most of the Upcountry area has between 30 to 60 inches of annual rainfall.

B. Existing Drainage Deficiencies

In general, the Upcountry area does not have any major drainage or flooding problems. Rainfall runoff flows or is directed to the many gulches which course through the area.

In the past, Makawao has been subjected to floods as a result of sheet flow over the highlands. This water flows down from developed areas into secondary roads and ponds in the Makawao area between the Olinda Intersection and Haleakala Road junction. Small culverts are unable to accommodate the runoff which also carries with it silt and debris. Although homes have only experienced minor water damage, yards and lawns have been inundated. New developments in the area, notwithstanding drainage improvements, have added to the sheet flow runoff on the lower areas.

Some drainage improvements including culverts and drain lines, have been made to portions of Makawao which have experienced flooding problems, including Makawao Avenue and along Maha and Ukiu Roads. Where necessary, culverts crossing roads have been installed to direct runoff to natural drainageways.

C. Proposed Improvements

A drainage improvements project is planned along Pahala Street, incorporating 36-inch to 54-inch drainlines leading to an existing channel across Maha Road (See Figure 10). There are no other plans for any major drainage system improvements in the Makawao region.

VII. PAIA-HAIKU COMMUNITY PLAN REGION

A. Overview

The Paia-Haiku region is located along the north shore of Maui between the urban center of Kahului and rural Hana. Elevation ranges from mean sea level to approximately 6,900 feet above mean sea level. The region is characterized by numerous gulches and intermittent streams as depicted in Figure 13. Major gulches in the region include Maliko Gulch, Kuiaha Gulch, West Kaupakulua Gulch, East Kaupakulua Gulch, and Kapili Gulch.

The region is composed of the Kula volcanic series which is chiefly of thicker alkalic aa flows. The area is mostly overlain with moderately deep and deep, gently sloping to steep well-drained soils that have a fine textured subsoil or underlying material. Annual rainfall in the region ranges from 30 inches in Paia to about 150 inches in the higher elevation areas.

B. Existing Drainage Deficiencies

The primary problem in the area is with the erosion of soil and deposition of soil and silt in the lower areas associated with heavy rainfall. Erosion is usually severe during periods of heavy rainfall on barren or newly planted crop fields in the Paia area. Damages have also been incurred when irrigation channels overtop their banks resulting in soil erosion. The Haiku area is affected by normal to severe damage to newly planted fields and roadways.

The community of Kaupakulua located near the East Kuiaha Gulch about three miles northeast of Makawao is frequently flooded by backwaters. The surrounding area is primarily used for grazing and any resultant runoff flows down nearby hills and gulches.

The drainage system in the region consists only of road culverts. During periods of heavy rainfall, minor flooding occurs on local streets. New developments in the area also contribute to flood problems. One such problem occurred on Baldwin Avenue near Paia where a road was constructed but no culvert provided for the relief of flooding waters. Flooding overtopped the secondary road, flowing over Baldwin Avenue and continuing to Paia School and School Village, resulting in damage to the area.

C. Proposed Improvements

The recommendations for drainage system improvements in the *Drainage Master Plan for the County of Maui* (October 1971) continue to serve as the guide for the Paia-Haiku area. To provide protection for Paia Town and the lower Paia area, a system of culverts and drainage ditches is proposed to be constructed to divert storm runoff away from the populated areas (See Figure 10). A culvert would be installed on the plantation road

located south of Baldwin Avenue and east of Paia School to alleviate flooding of the Maui Children's Home during times of severe runoff. A lined channel of approximately 3,000 feet in length would be constructed north of Paia School to divert the flow around the school and surrounding areas. The flow from the diversion channel would then be diverted from its natural course until it reaches lower Hamakuapoko Road. At this point, a lined ditch approximately 2,000 feet in length would be constructed to divert the flow away from lower Paia. A third lined channel approximately 850 feet in length is proposed to transport stream runoff flow from above Hana Highway to the ocean. A culvert is also proposed for this channel system to relieve the flow across Hana Highway.

VIII. HANA COMMUNITY PLAN REGION

A. Overview

The Hana region is located on the eastern portion of the Island, with Hana Town being on the easternmost shoreline. Topography in the region is relatively flat in the coastal areas, rising gently to higher elevations within the western portion of the region. Encompassing the eastern half of Haleakaka, rainfall in the region ranges from over 150 inches annually along the Keanae shoreline to only 20 inches along the Kahikinui coastline. Steep slopes and rugged shorelines characterize the region, as do mountain rainforests, perennial and intermittent streams, and open ranch lands.

The region is predominantly composed of the Hana volcanic series which is overlain by moderately deep and deep, gently sloping to steep, well-drained soils in the coastal areas, and gently sloping to steep, well-drained to poorly drained soils in the higher elevations.

Major drainageways for the Hana region are presented in Figure 14.

B. Existing Drainage Deficiencies

Following the storm of April 15 – 16, 1968, the Hana District was declared a disaster area by the State of Hawaii. A 200-foot section of a concrete rubble masonry ditch along the road directly north of the Hana Hotel was severely damaged and sections of the lining, bedding and banks were washed downstream and into the ocean.

An inadequately sized drainage ditch on the mauka side of the roadway fronting the Hana Hotel resulted in sheet flows from pasture lands located mauka to overtop the roadway, causing damage to the hotel.

Damage also occurred to the road shoulders, retaining walls, and pavement on approximately 50 feet of the lower Hana Road near Holoinawawae Stream. Furthermore, damages to Hana Highway in locations outside of this study area were extensive. In many sections, water and debris resulted in the highway being impassable, with sections of the roadway washed out and traffic blocked due to small landslides.

Existing drainage improvements include a concrete-lined open channel along Keawe Place from Hana Highway to Hana Bay.

C. Proposed Improvements

The recommendations for drainage system improvements in the *Drainage Master Plan for the County of Maui* (October 1971) continue to serve as the guide for the Hana area. The

proposed drainage improvements are depicted in Figure 14. To provide for the collection of sheet flow of the areas directly mauka of the Hana Hotel, an improvement to the existing diversion channel is proposed. Also, an unlined diversion ditch approximately 2,100 feet in length is proposed north of Kawaipapa Stream. This channel would divert the sheet flow from the upper areas and protect the residential areas on both sides of Hana Highway.

IX. MOLOKAI COMMUNITY PLAN REGION

A. Overview

The areal limits of this assessment encompass Kaunakakai Town and its immediate vicinity. Kaunakakai, the Island's major population and commercial center, is located about midway along the south coast. Topography in the general vicinity ranges from a flat coastal plain to steep slopes and gulches higher in the mountains. Drainage areas in the vicinity of Kaunakakai extend northeast into the upper portions of the East Molokai Mountains. Within the Kaunakakai watershed, which encompasses approximately 7,144 acres, the average elevation is about 5 feet mean sea level along the coastal plain, rising to about 4,200 feet on the upper slopes of the East Molokai mountains. Well-defined gulches mark the upper elevations, while delineation in coastal areas varies and is much less pronounced. As some watercourses approach the coast, they become poorly defined and end before reaching the ocean.

Major drainageways for the Kaunakakai region are presented in Figure 15.

B. Existing Drainage Deficiencies

Drainage problems and flood conditions from runoff during periodic rain and storm events have plagued the Kaunakakai area for years. The flooding is caused by a combination of natural and manmade factors. These include inadequate or nonexistent drainage systems in the business areas of Kaunakakai town, inadequate drainageways to convey the runoff from existing systems in the upper portion of the town to the ocean, poorly maintained drainage systems, poorly drained soils in low-lying areas, and flat terrain.

The existing drainage system in Kaunakakai consists of ditches, levees, grassed swales, berms, roadway culverts, catch basins, and drainlines. These systems were designed to convey, divert, or retain runoff generated within the vicinity. However, many of these systems are badly in need of maintenance, and many of the downstream systems (ditches and roadway culverts) are incapable of accommodating the runoff generated from developed conditions upstream. In addition, several of the roadway culvert crossings were noted to have outlet inverts lower than the invert of the outlet drainageway, resulting in ponding during periods of flow.

The existing drainage system for Kaunakakai is described by the following five sub-areas:

1. Kaunakakai Stream

The portion of Kamehameha Highway which crosses Kaunakakai Stream is designed as a ford. During periods of heavy flows, water will overtop the crossing. The Kaunakakai

Stream levee was designed and constructed by the COE and serves to prevent overflowing of the stream during periods of heavy rain. The levee was designed for a 100-year flow of approximately 14,000 cfs. Although Kaunakakai Stream overflows Kamehameha Highway during periods of heavy rainfall, the levee has prevented flooding from occurring within the town area. The main problem with the stream overflowing the ford is the inability to get from one side of the stream to the other. Thus, access to emergency services is severely hampered.

2. Kaunakakai Town to Beach Place

Recent drainage improvements include a berm/triangular grassed ditch combination approximately 1,100 feet in length along with a 24-inch RCP culvert located just above the business district of Kaunakakai, generally following the southern boundary of Molokai General Hospital. The berm/grassed ditch ties into the existing COE levee along the Kaunakakai Stream bank and serves as a diversion for runoff generated above the Town's center.

Within the town's business district, there are no existing drainage systems. During periods of heavy rainfall, flooding occurs along Ala Malama Drive, Alohi Street, and Mohala Street. The flooding problem is compounded by the reduced carrying capacity of the concrete gutters along Ala Malama Drive. The reduced capacity of the gutters is the result of road resurfacing without sufficiently planing the previous road surface.

On Kamehameha Highway, the invert of an existing 24-inch culvert is about 12 inches above the existing ground. Because the ground is not graded to drain towards the culvert's inlet, water tends to accumulate in low points within the County's storage yard.

Within the town, an inlet/catch basin system is located at the intersection of Kamehameha Highway and Ala Malama Drive. This drainage system consists of four inlets and a slotted drain which empties into a ditch adjacent to the Highway. A second roadside ditch on the south side of the Highway should convey the flow to the west and around the wastewater pumping station and then south towards the ocean. However, most of the runoff ponds in the ditch alongside of the Highway since the ditch lacks enough slope to drain into the ocean.

Approximately 22 cfs of runoff generated within the area bounded by Kaunakakai Place, Mohala Street, Kamehameha Highway, and Beach Place was designed to drain to the ocean through two culverts. However, as the result of poor grading, most of the runoff in this area ends up ponding within low points in the area north of Beach Place.

3. Upper Kaunakakai Subdivision

A ditch and associated 8- to 10-foot high levee are located just north of the upper boundary of the town's existing subdivision developments, and serves as the primary diversion for runoff generated on the hill slopes above the town. The ditch outlets into Kaunakakai

Stream and, during times of heavy rainfall, the ditch/levee system essentially acts as a detention basin.

In addition to the levee and ditch, a grassed swale located directly above the subdivision lots conveys additional runoff east towards the Puu Maninikolo cinder pit. However, the capacity of the swale has been reduced by a heavy growth of grass.

The subdivisions below or south of the diversion ditch/levee are served by several drainline and catch basin systems. However, one silting basin (basin "A") is badly overgrown with tall grass and koa trees, and has a large build-up of silt material which has essentially reduced the capacity of the basin by 75 percent. Another silting basin (basin "B") is also overgrown with tall grass and some koa trees, but the accumulation of silt is much less pronounced than basin "A". In spite of the heavy growth in both basins, both appear to be structurally stable.

4. Kaunakakai School to Seaside Place

A culvert which transitions to a grassed swale south of Kolapa Place and eventually to a grassed trapezoidal ditch, has reduced capacity due to heavy growth of grass in the ditch. The ditch drains to a box culvert which conveys flows to the south side of the Highway. However, the midpoint of this culvert is partially clogged with a thick layer of silt and dead vegetation. As such, the middle portion of the culvert has a reduced clearance which has effectively reduced the capacity of the culvert. The box culvert does not outlet into a defined drainageway after crossing the Highway. Once the flow is on the south side of the Highway, the water ponds in a small marshy area adjacent to the Highway known as the Goodfellow property. Originally a wetland area, the property has been filled in, thus preventing any water to outlet into either the marsh or the ocean.

A culvert serves as a second highway crossing for the swale and also serves as a ditch relief line. The outlet for the culvert consists of a concrete-lined trapezoidal channel. The capacity of this channel has been reduced considerably due to debris build-up in the channel.

5. Kapaakea Subdivision

The drainage system for the Kapaakea Loop area consists of two culverts crossing the Highway. Both culverts are in need of maintenance, as silt and dead vegetation have accumulated within the culverts. Also, both culvert outlet inverts are lower than the

existing drainage ditches, thus resulting in ponding at the outlets. The outlet for one of the culverts consists of a graded ditch. Although much of this ditch is in good condition, there are several locations in which residents have completely blocked it by filling it in with soil and planted vegetation. As such, these obstructions have caused water to build up at the outlet end of the culvert. A grassed ditch which drains the other culvert has reduced capacity due to heavy overgrowth. Both ditches do not have culvert crossings to pass

water through the Kapaakea Loop before outletting into the ocean. As such, during times of heavy rainfall, runoff flows over the roadways to the ocean.

Previously, the COE s planned a second flood control project within the town which would have consisted of a concrete-lined channel along with levees above Kapaakea. However, the proposed project was cancelled in 1978 due to insufficient funds.

C. Proposed Improvements

The *Drainage Master Plan for Kaunakakai, Molokai, Hawaii* (August 1992) proposes drainage improvements for Kaunakakai Town and its immediate vicinity to address the inadequacies in the existing system. The proposed system has been designed to accommodate future development as designated in the *Molokai Community Plan* (January 1984). The system consists of a combination of drain lines, grated inlets, catch basins, box culverts, and shallow open channels designed for a 10-year storm. Proposed roadway culvert crossings are designed for a 50-year storm.

The system is divided into five separate sub-systems, each addressing individual problem areas. The following is a summary of the proposed systems and individual design features which are depicted in Figure 15.

System “A”: System “A” is located just above the business district of Kaunakakai generally following the southern boundary of Molokai General Hospital. The system consists of a berm/triangular grassed ditch combination approximately 1,000 feet in length, along with a new 24-inch RCP culvert. The berm/grassed ditch would tie into the existing COE levee along the Kaunakakai Stream bank and serve as a diversion for runoff generated above the town’s center. Estimated cost is \$278,740 each for an open channel system (scheme 1) and an underground system (scheme 2).

System “B”: System “B” consists of a combination box culvert/grate inlet and open channel system. This system would serve to drain the center of the business district, the County storage yard, and land directly east of Kaunakakai Place. The drain line portion would consist of concrete box culverts which would run under Ala Malama Drive. After passing under Kamehameha Highway through a new box culvert, the drain line would drain to a 970-foot long concrete open channel that outlets to the ocean. A new 24-inch RCP culvert would drain runoff from the County storage yard into a channel which would then discharge through a series of new box culverts and a channel before emptying into the ocean. Estimated costs are \$2.3 million for an open channel system (scheme 1) and \$2.5 million for an underground system (scheme 2).

System “C”: System “C” consists of a combination box culvert/grade inlet and open channel system. This system would drain the town’s business district portion southeast of Ala Malama Drive, and areas south of Kamehameha Highway, which would include land straddling Mohala Street down to Beach Place. The box culvert/grate inlet portion would start along Alohi Street and run under Mohala Street to Kamehameha Highway. After crossing under the Highway through a new box culvert, the system would empty into a concrete-lined channel. A second cut-off channel would empty through a new box culvert which would then transition to a channel. After crossing under Beach Place with two new box culverts, the channel would continue to the ocean. Estimated costs are \$1.3 million for an open channel system (scheme 1) and \$2.0 million for an underground system (scheme 2).

System “D”: System “D” follows four existing ditches and consists of concrete-lined channels which would drain runoff generated from portions of the town’s subdivisions. The channel would also serve as a collection channel for runoff generated from the grassed recreational field and cultivated lands adjacent to Kamehameha Highway. This rectangular channel would cross Kamehameha Highway through an existing box culvert and a new twin RCP crossing, with flows ultimately being diverted to the ocean through a channel. Estimated costs are \$1.6 million for an open channel system (scheme 1) and \$3.9 million for an underground system (scheme 2).

System “E”: System “E” consists of two concrete-lined channels which would run 600 feet from Kamehameha Highway to the ocean. A new channel would replace an existing ditch and drain flow from the unnamed stream. A new box culvert would convey flow across Kamehameha Highway, while another new box culvert would cross Kapaakea Loop. A second channel would drain flow from Kamiloloa Stream. Two new box culverts would convey flow under Kamehameha Highway, and a second group of new box culverts would allow flow to pass under Kapaakea Loop. Estimated cost is \$1.1 million each for an open channel system (scheme 1) and an underground system (scheme 2).

The *Drainage Master Plan for Kaunakakai, Molokai, Hawaii* (August 1992) also includes the following additional recommendations to the above proposed drainage systems:

Future Development: In addition to the proposed drainage systems, it is also recommended that the County adopt and enforce policies on minimizing any adverse effects due to future developments. Until the proposed drainage systems are implemented, future developments should not increase stormwater runoff unless it can be shown that the existing downstream drainage system has adequate capacity to accommodate the additional flow. Also, in addition to the proposed systems, a separate system above the existing subdivision would be required if the land above it is developed.

Maintenance Program: It is also recommended that the County institute a regular inspection and maintenance program for the drainage system. This could include inspections conducted on a semi-annual basis, follow-up inspections and maintenance after heavy rains, institution of a regular maintenance program, and grassing eroding areas.

Flood Control: Within the Kapaakea Subdivision, the master plan addresses the use of two channels (System “E”) to convey runoff above the subdivision. However, it is recommended that the County pursue the use of a diversion berm/flood control channel to convey the flow around the subdivision and through the Goodfellow property before outletting into the ocean. The implementation of System “E” alone does not eliminate the need for the diversion berm/flood control channel.

Kamehameha Highway: During flood conditions, Kaunakakai Stream overflows the ford on Kamehameha Highway. A new bridge, while costly, would allow free travel across the stream during flood conditions.

X. LANAI COMMUNITY PLAN REGION

A. Overview

Lanai City is situated on the central plateau just below Lanaihale, the Island's volcanic peak and highest point. Although Lanai City is situated in the relatively flat plateau portion of the Island, a number of gulches are located to the east/southeast within the faulted cliff areas. Major gulches in proximity to Lanai City include Kaiholena Gulch and Kapono Gulch. The Island is composed of the Lanai volcanic series and, in the vicinity of Lanai City, is overlain by deep, nearly level to moderately steep well-drained soils.

Major drainageways for the Lanai City region are presented in Figure 16.

B. Existing Drainage Deficiencies

For the most part, drainage basins on Lanai are difficult to define primarily due to the lack of definitive streams flowing throughout the Island, and due to the differing ground slope of individual basins. On the windward side of the Island, most gullies are deep and dry throughout most of the year. During periods of heavy rainfall, however, considerable runoff is generated resulting in occurrences of extensive erosion.

There has been little information compiled to date with regard to flooding problems on the Island. The relatively good drainage pattern around Lanai City has reduced flood damage conditions. During periods of heavy rainfall, low lying areas within Lanai City are inundated by shallow ponding of water for short durations. The definite slope of the terrain within the vicinity of Lanai City provides for natural drainage of almost all roadways in the area. A natural depression protects the northeast section of the town from flooding due to sheet runoff. Additionally, drain lines have been installed along Lanai Avenue.

Storm runoff from the nearby Koele Resort development is ultimately discharged into Kaiholena Gulch and Kapono Gulch located east and southeast of Lanai City, respectively. Kapono Gulch is a deep gulch with the capacity to carry any increased runoff from the Resort's golf course without any drainage impact on downstream developments.

C. Proposed Improvements

The proposed drainage system improvements are associated with the Koele Resort near Lanai City as set forth in the *Koele Project District Infrastructure Master Plan, Final* (July 30, 1993). The proposed drainage improvements are depicted in Figure 16. Storm runoff in the mauka area of Gulch 1 will be collected by drain lines and discharged into an existing golf course lake. Storm runoff from other areas of Gulch 1 will flow to existing retention basins located within the Experience at Koele Golf Course, then to existing drain

lines for ultimate discharge into Kaiholena Gulch. The proposed system would decrease the current drainage basin that contributes to Kaiholena Gulch and reduce the discharge into the gulch.

Storm runoff from the Gulch 2 area will be collected in the proposed drainage system and discharged by two 72-inch drain pipes into Kapono Gulch. The proposed drainage system will intercept most of the surface flow to the existing ditch above the Lalakoa Subdivision. The drainage basin that contributes to and flows into Kapono Gulch will increase; however, most of the surface runoff will be collected and discharged at the bottom of Kapono Gulch which has adequate capacity to carry the increased volume of storm runoff.

The estimated cost of the proposed drainage system improvements is \$6.3 million.

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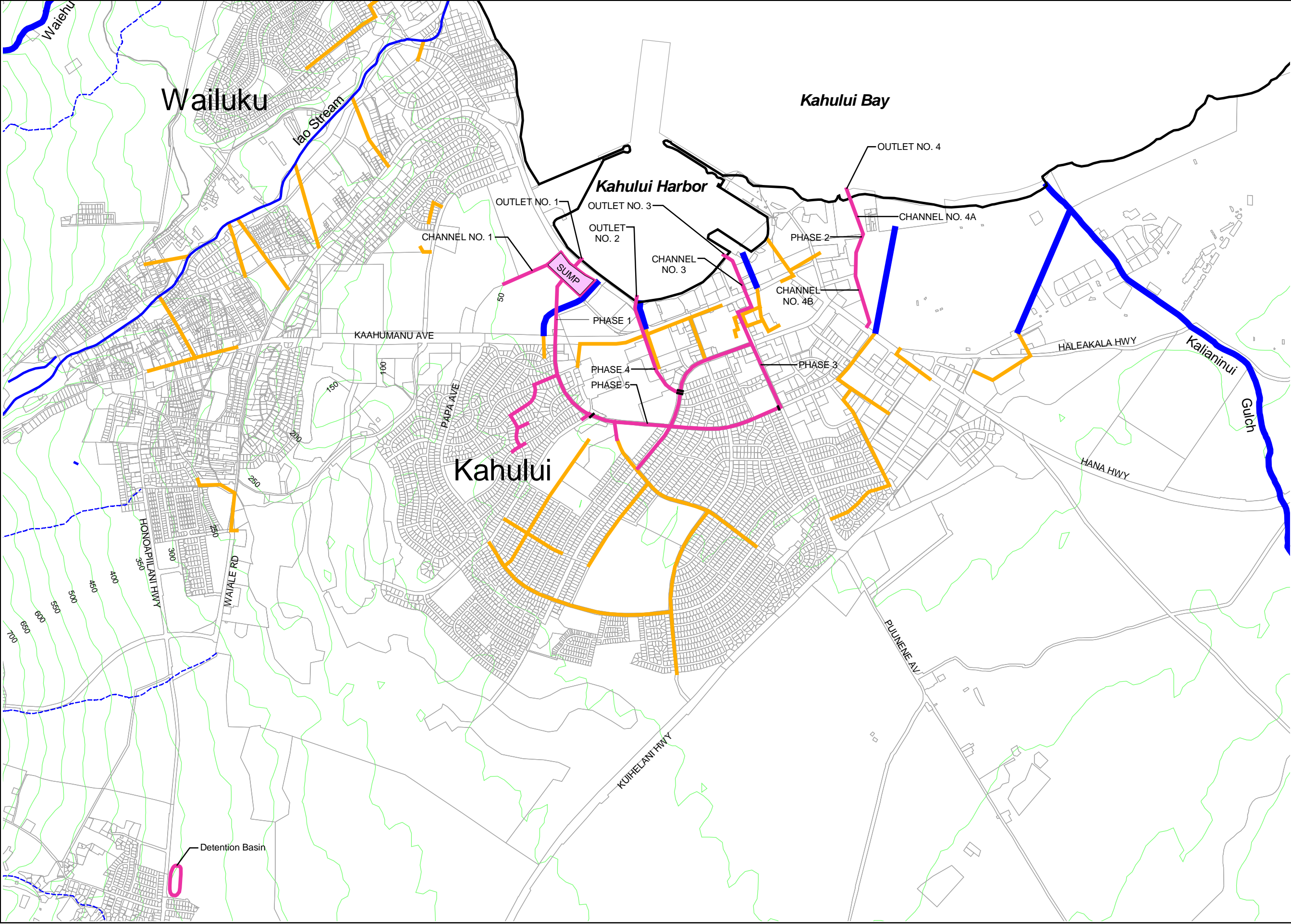
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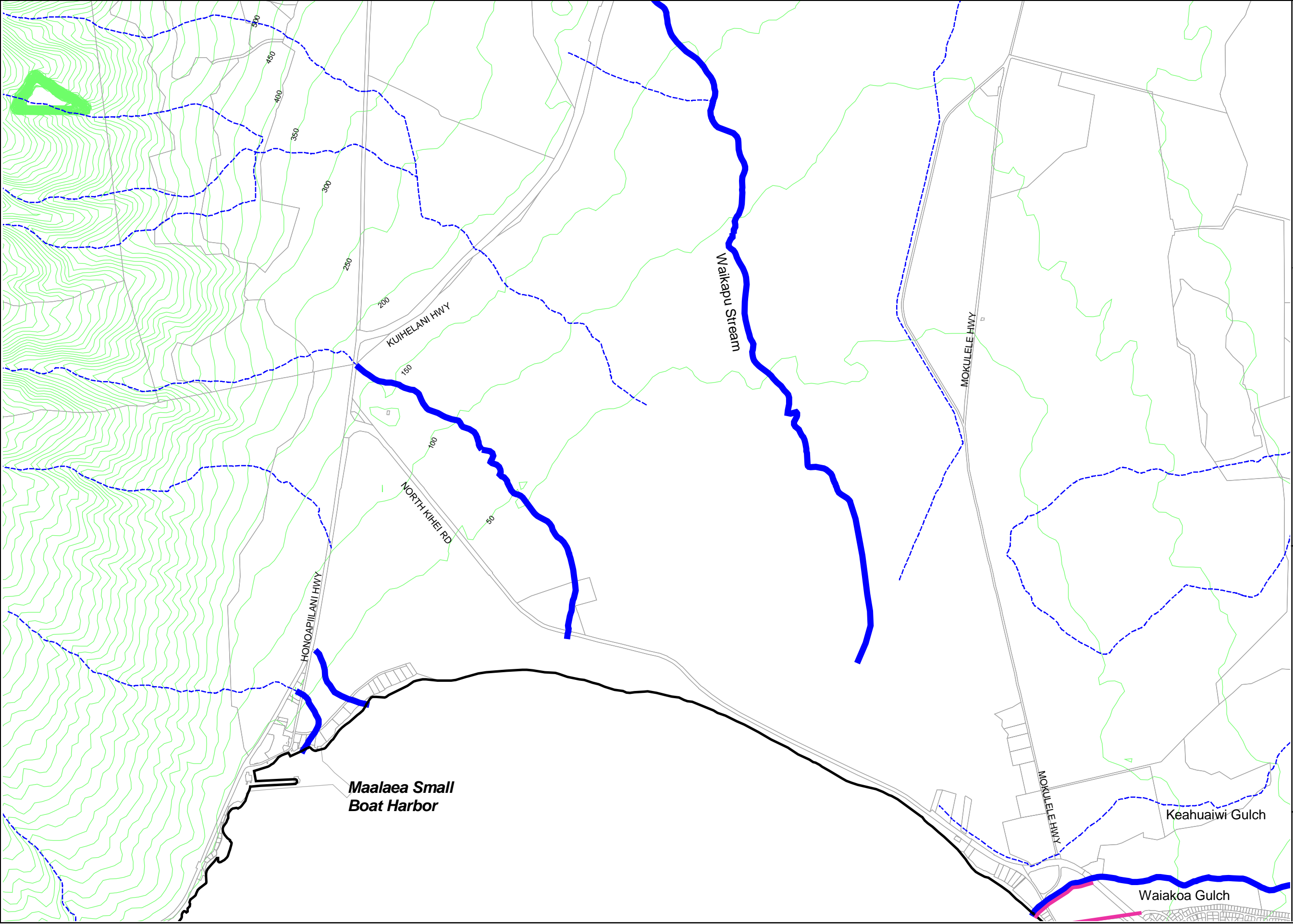
FIGURE 1
Wailuku-Kahului
Major Drainageways
and
Proposed Improvements

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements

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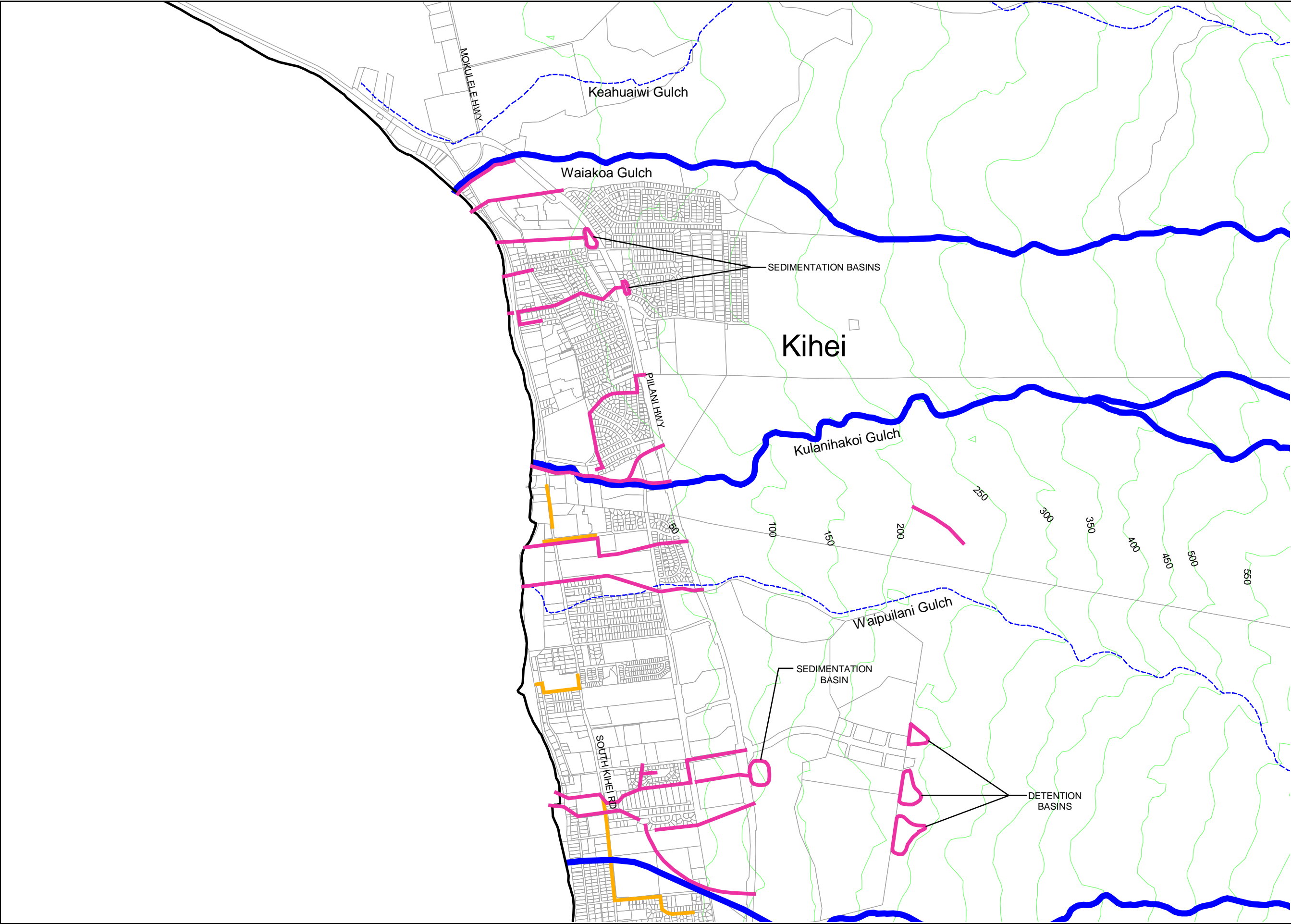
FIGURE 2
Kihei-Makena
Major Drainageways
and
Proposed Improvements

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements

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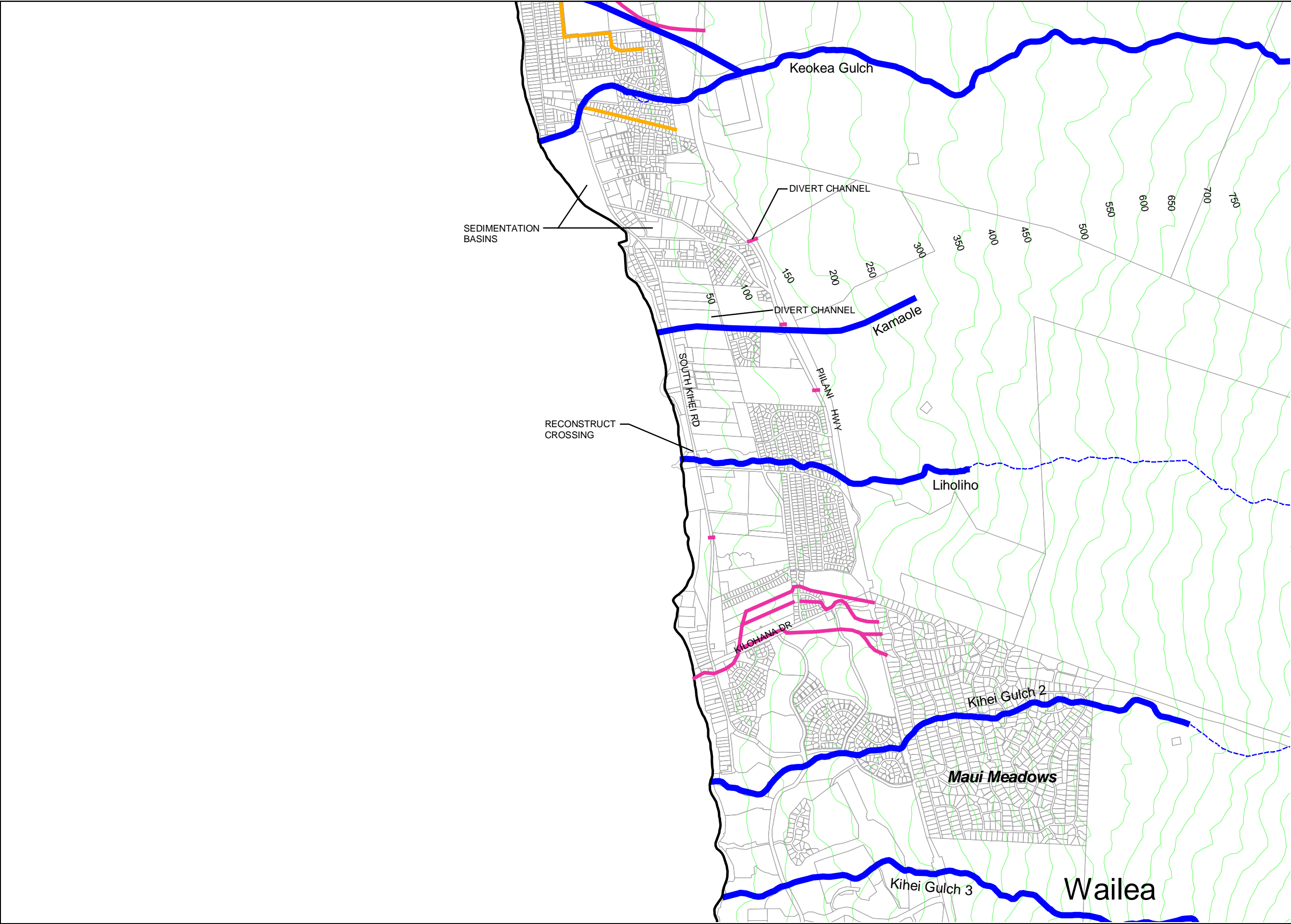
**FIGURE 3
Kihei-Makena
Major Drainageways
and
Proposed Improvements**

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements

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FIGURE 4
Kihei-Makena
Major Drainageways
and
Proposed Improvements

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements

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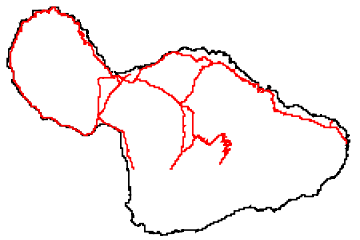
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FIGURE 5
Kihei-Makena
Major Drainageways

LEGEND

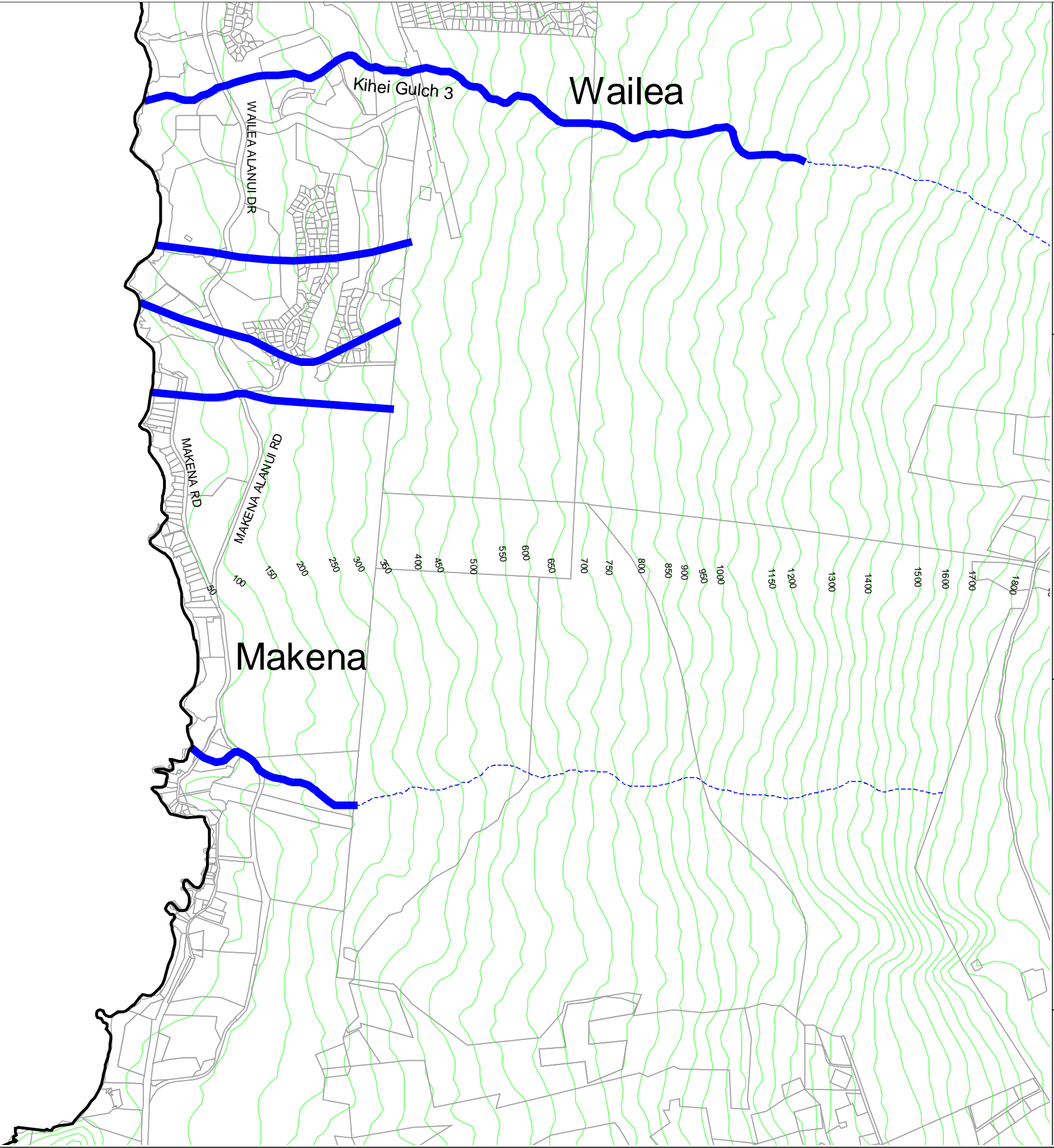
- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour

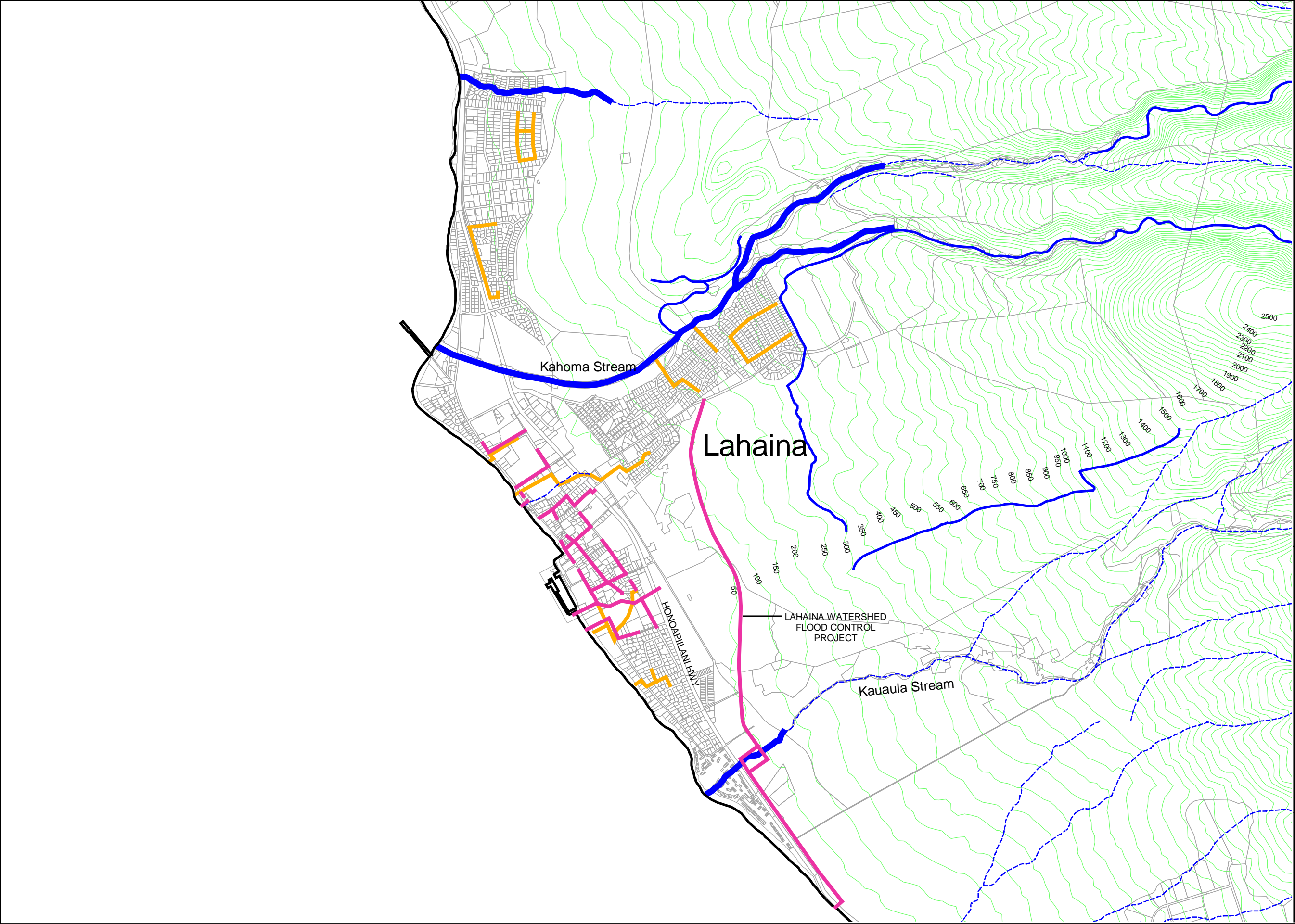


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**FIGURE 6
West Maui
Major Drainageways
and
Proposed Improvements**

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements

1000 0 1000 2000 Feet

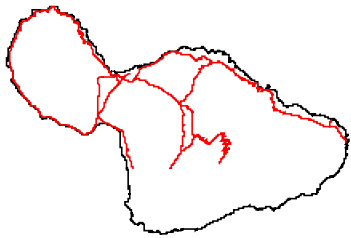
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FIGURE 7
West Maui
Major Drainageways

LEGEND

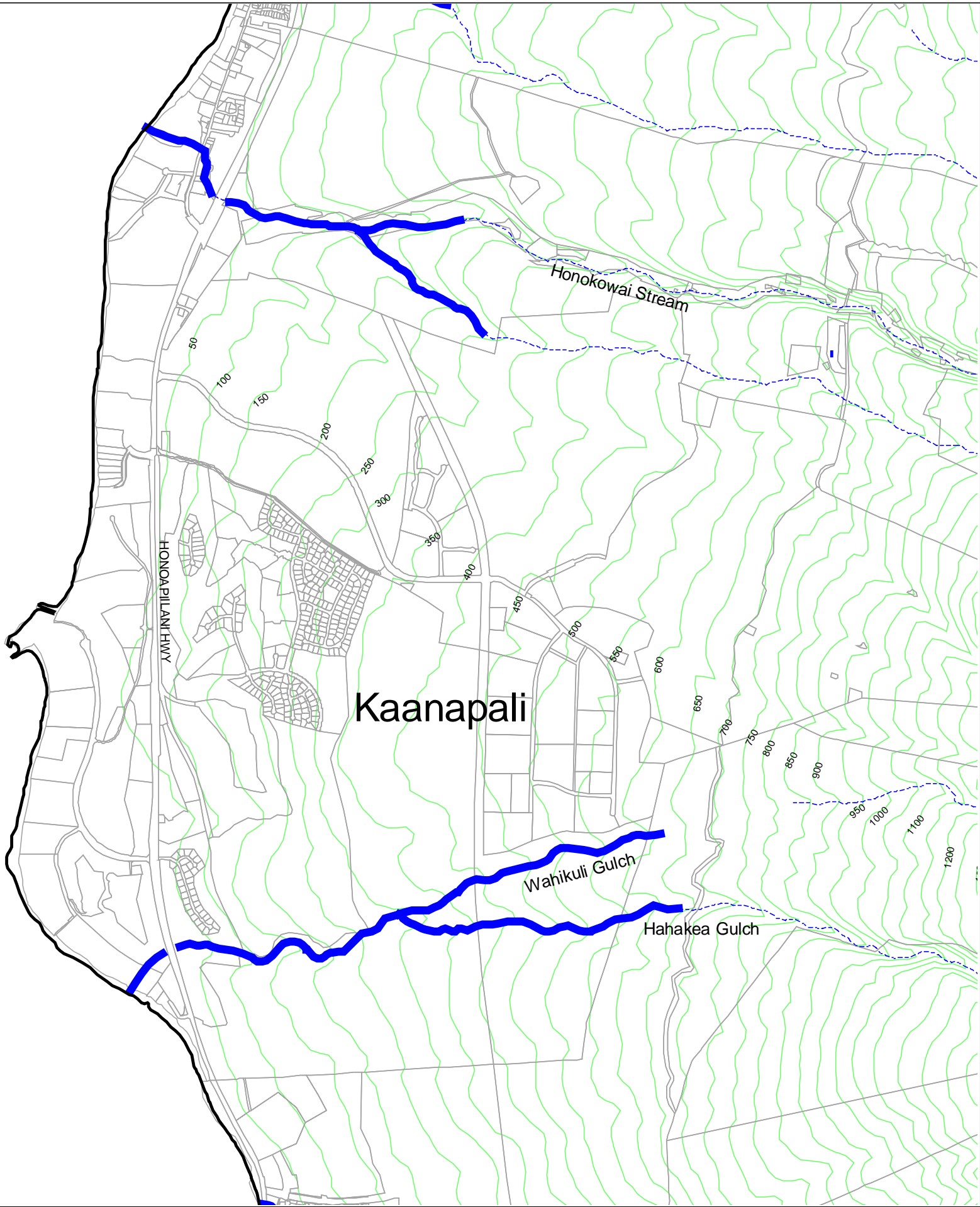
- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour

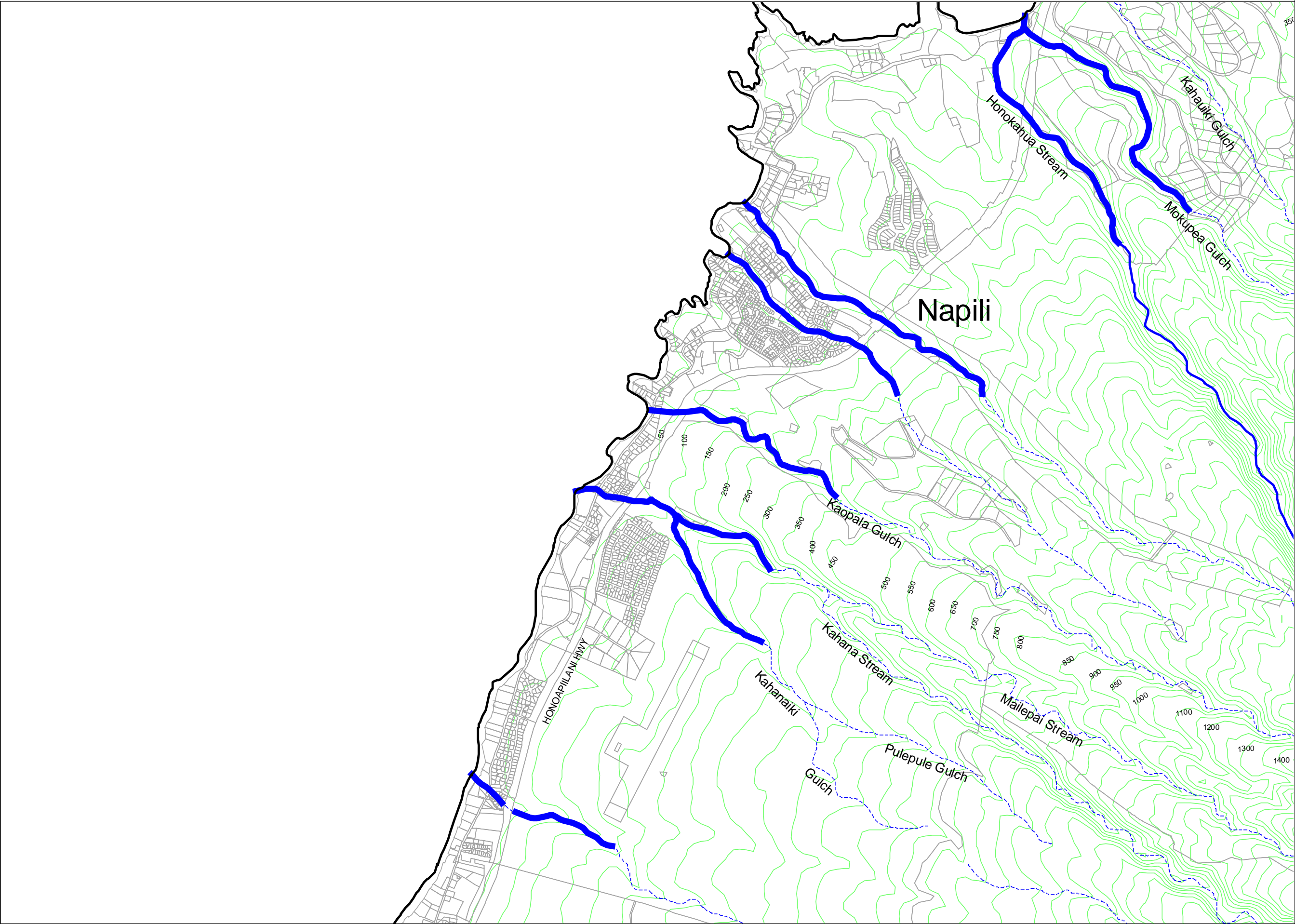


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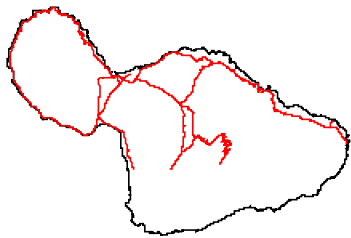


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FIGURE 8
West Maui
Major Drainageways

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour



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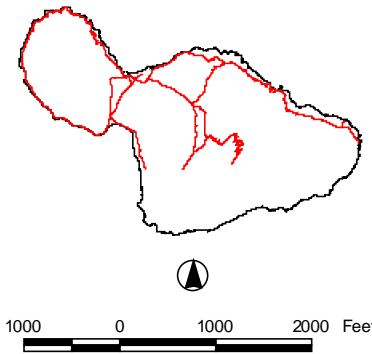
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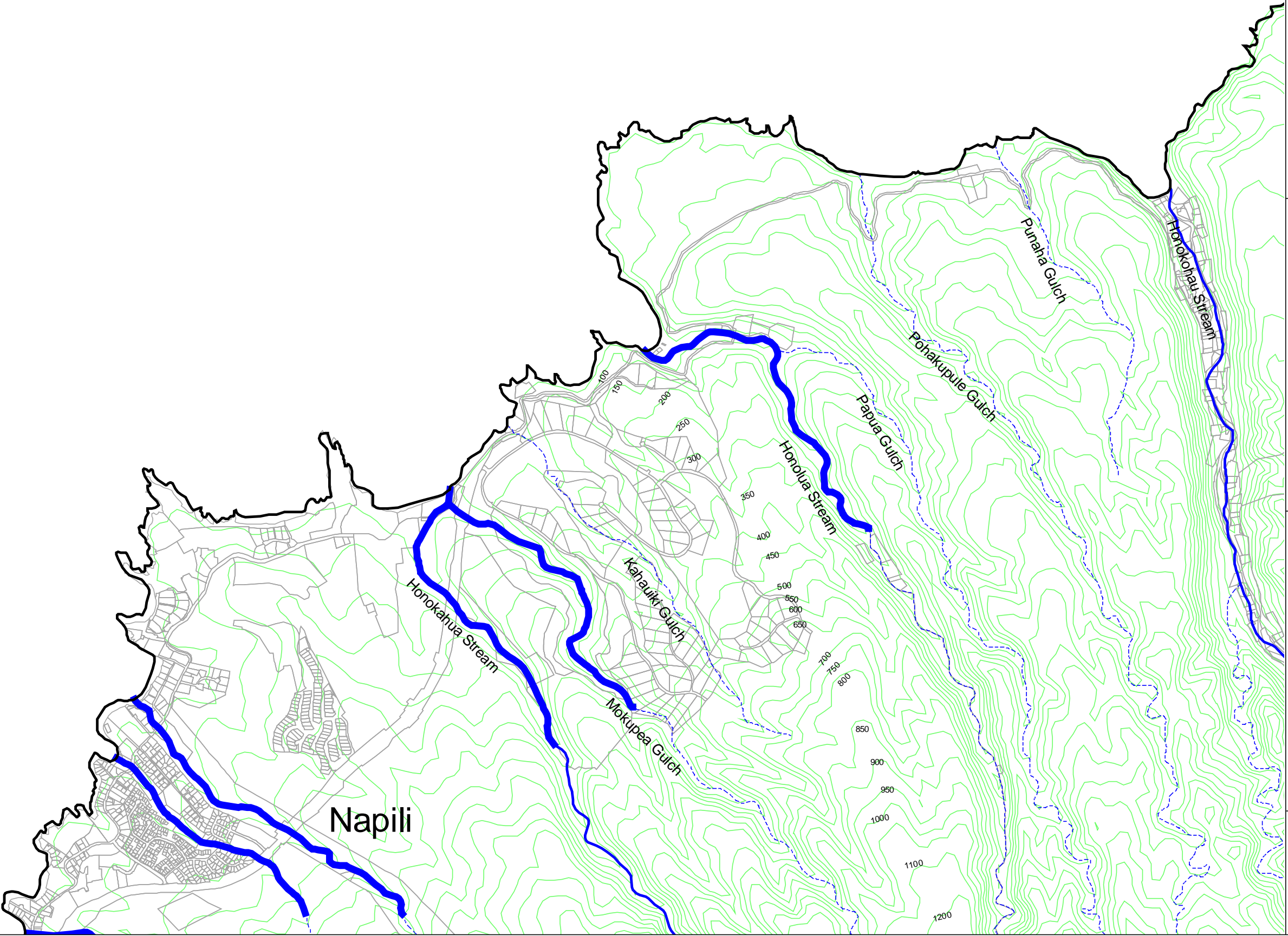
FIGURE 9
West Maui
Major Drainageways

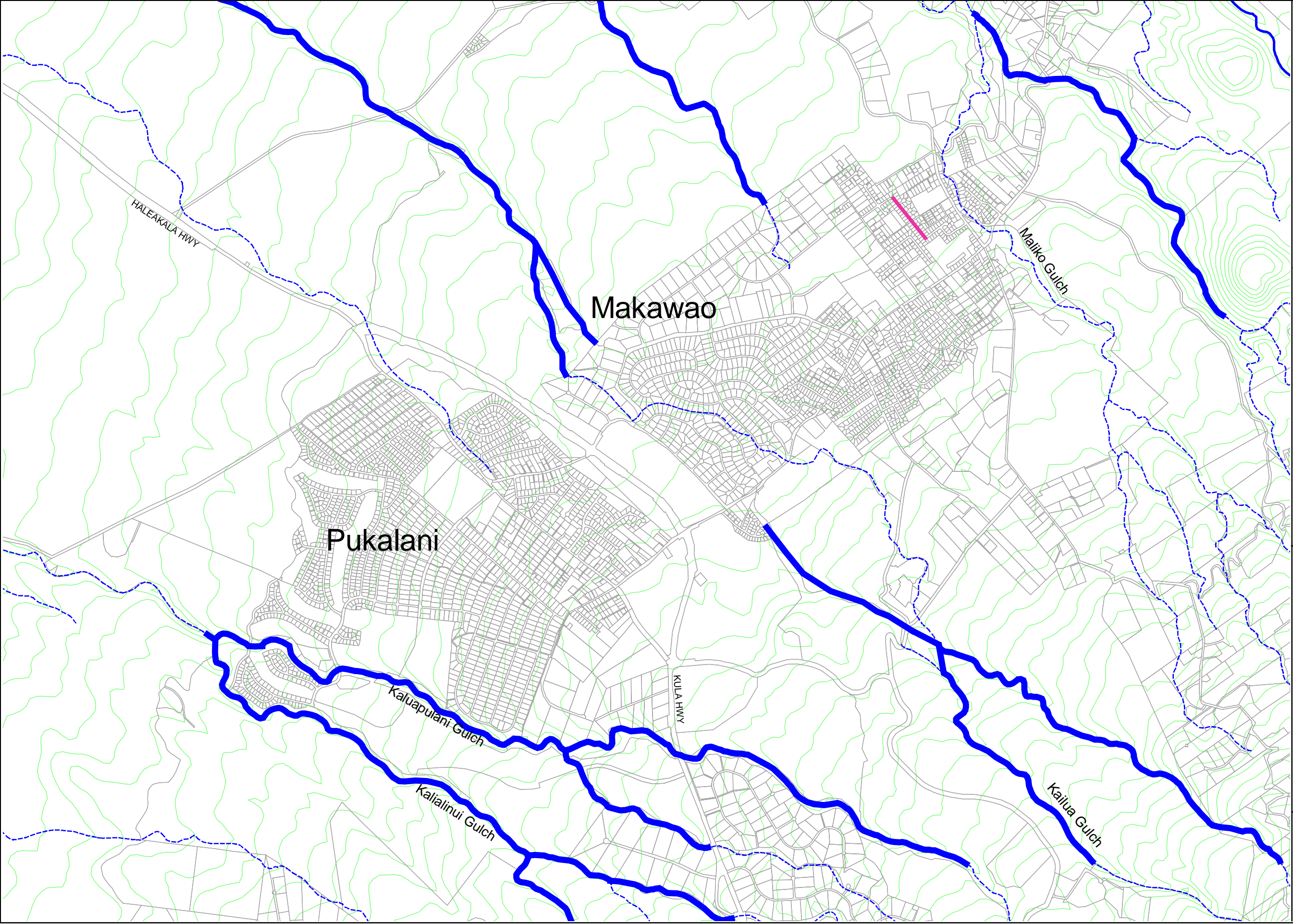
LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour



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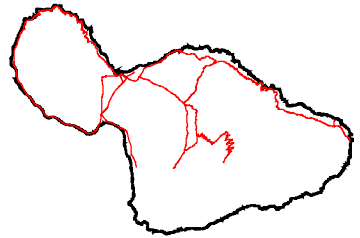


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FIGURE 10
Makawao-Pukalani-Kula
Major Drainageways
and
Proposed Improvements

LEGEND

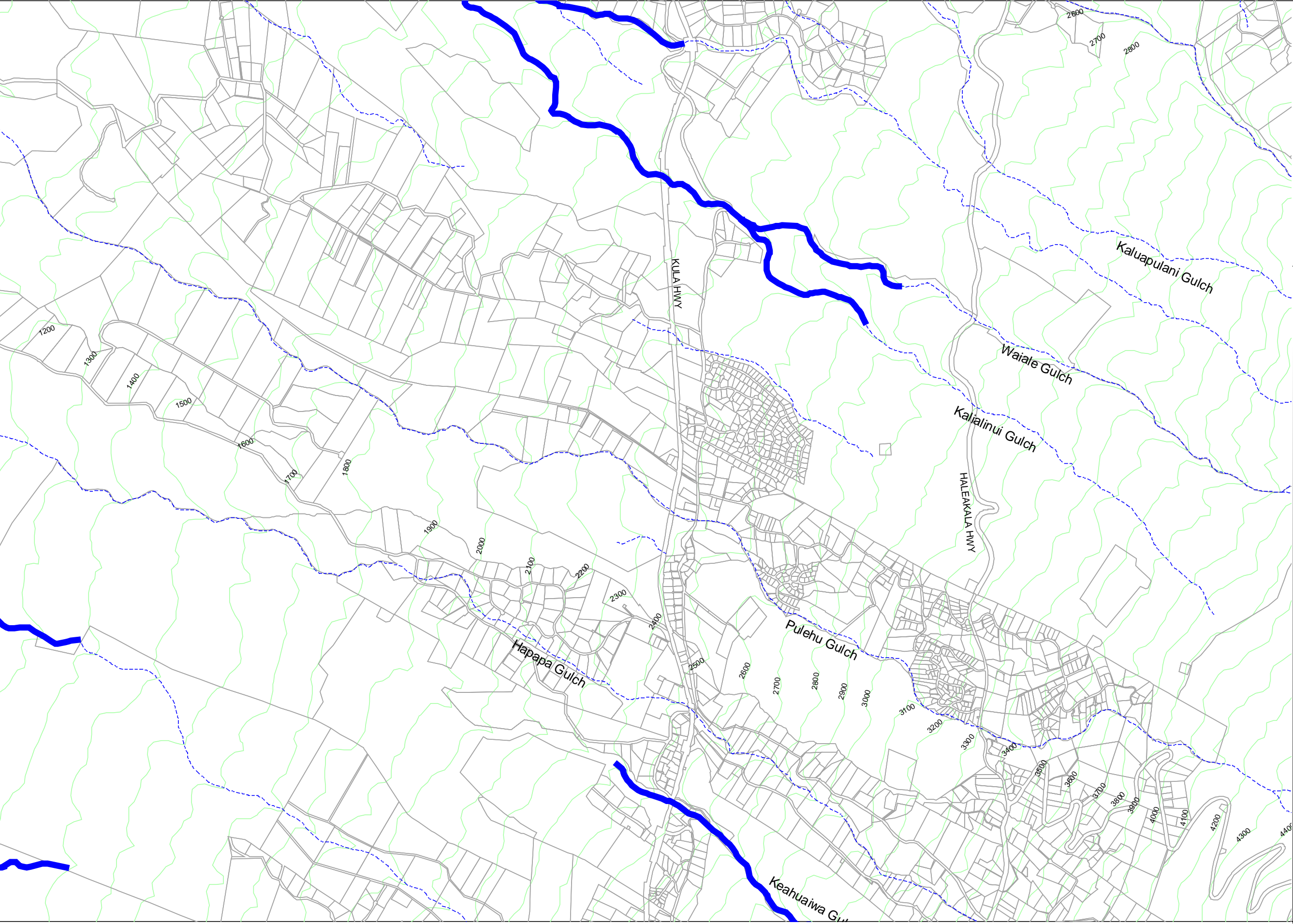
- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements



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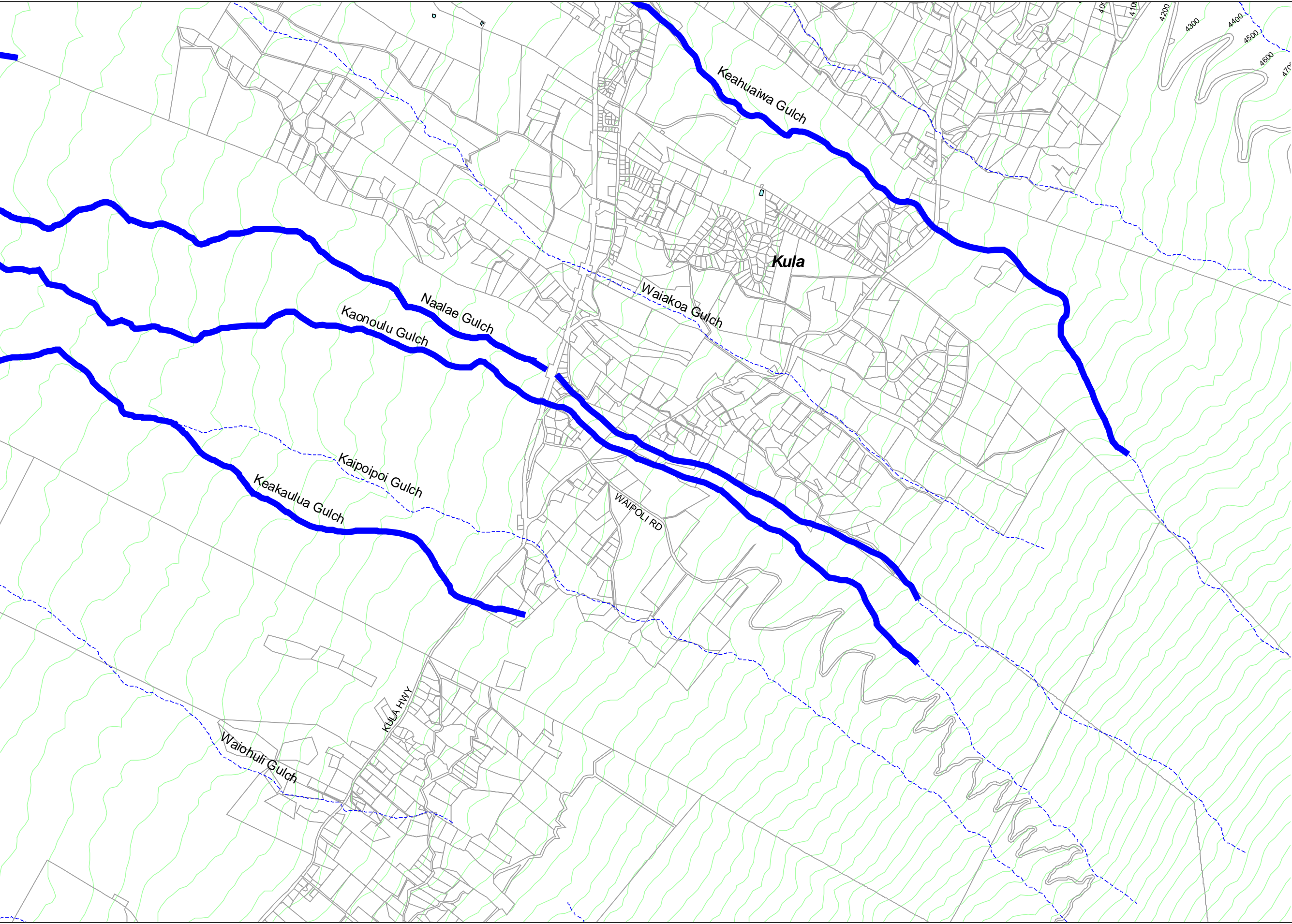
FIGURE 11
Makawao-Pukalani-Kula
Major Drainageways

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour

1000 0 1000 2000 Feet

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FIGURE 12
Makawao-Pukalani-Kula
Major Drainageways

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour

1000 0 1000 2000 Feet

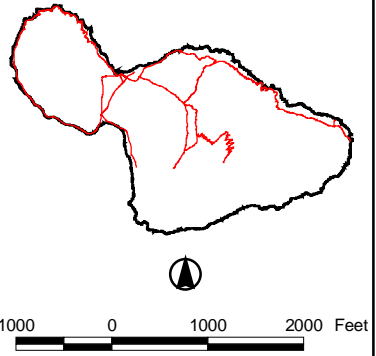
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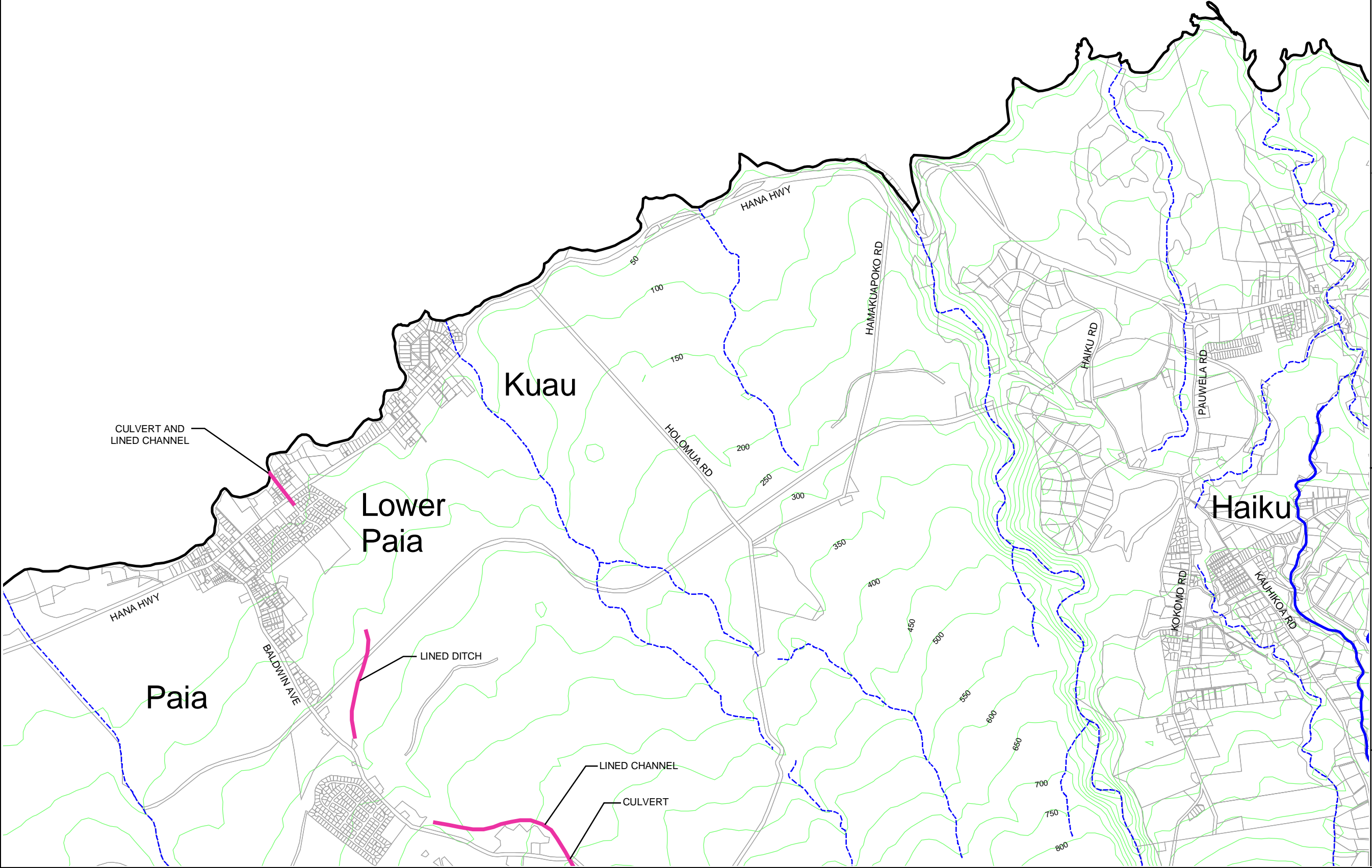
FIGURE 13
Paia-Haiku
Major Drainageways
and
Proposed Improvements

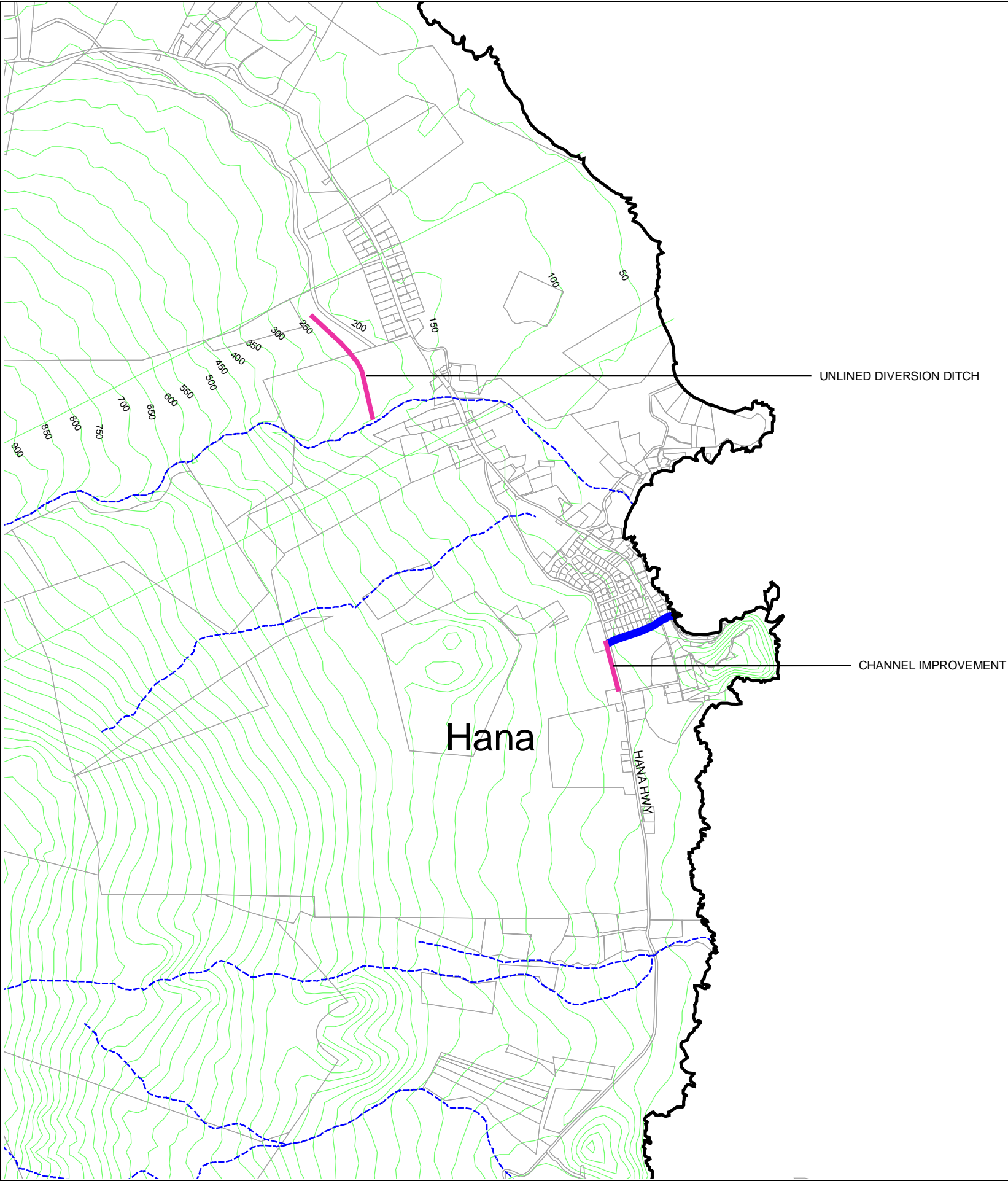
LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements



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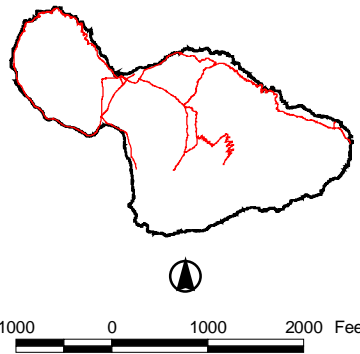


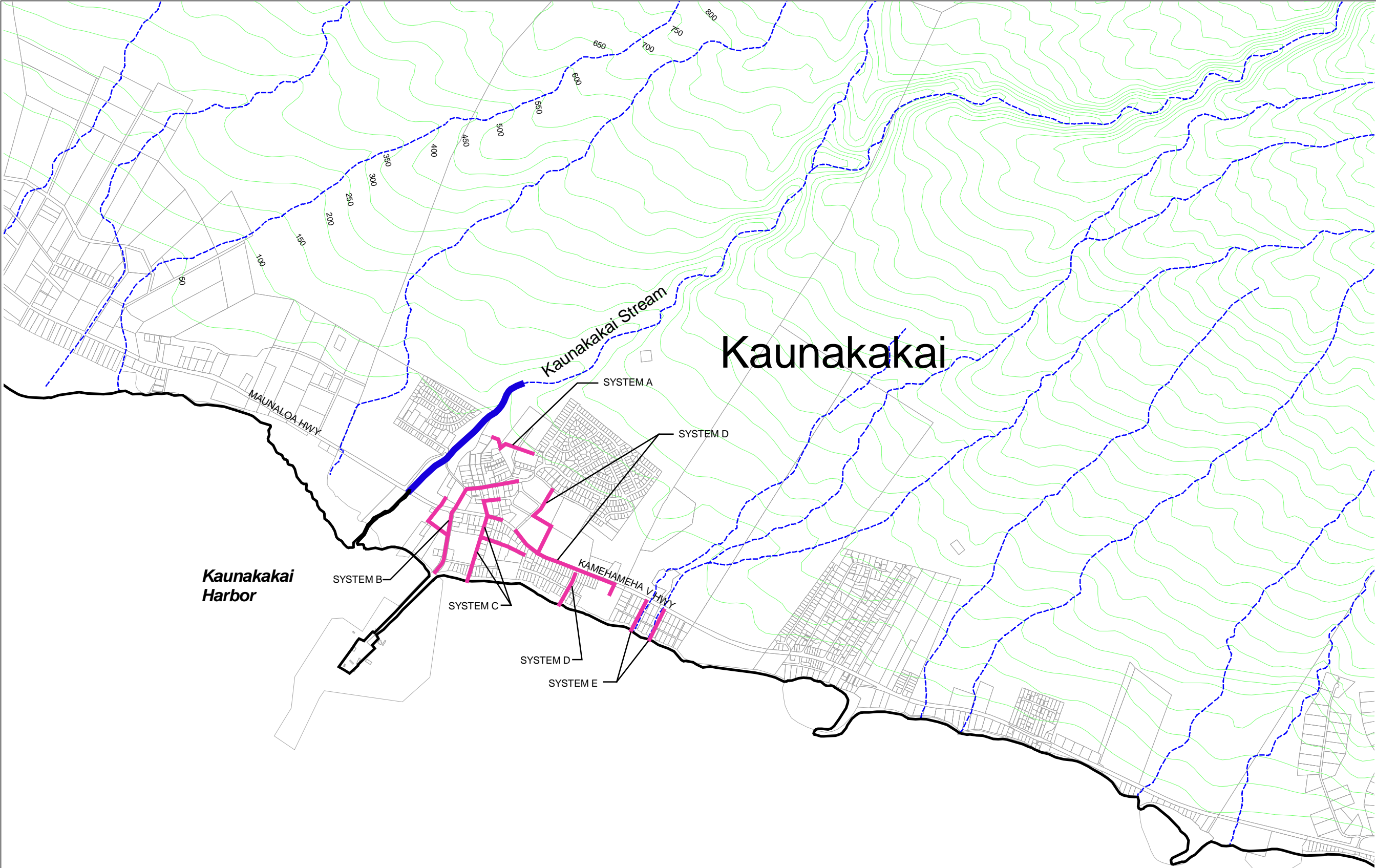
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FIGURE 14
Hana
Major Drainageways
and
Proposed Improvements

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements



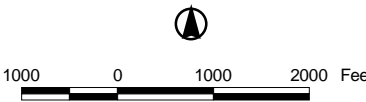


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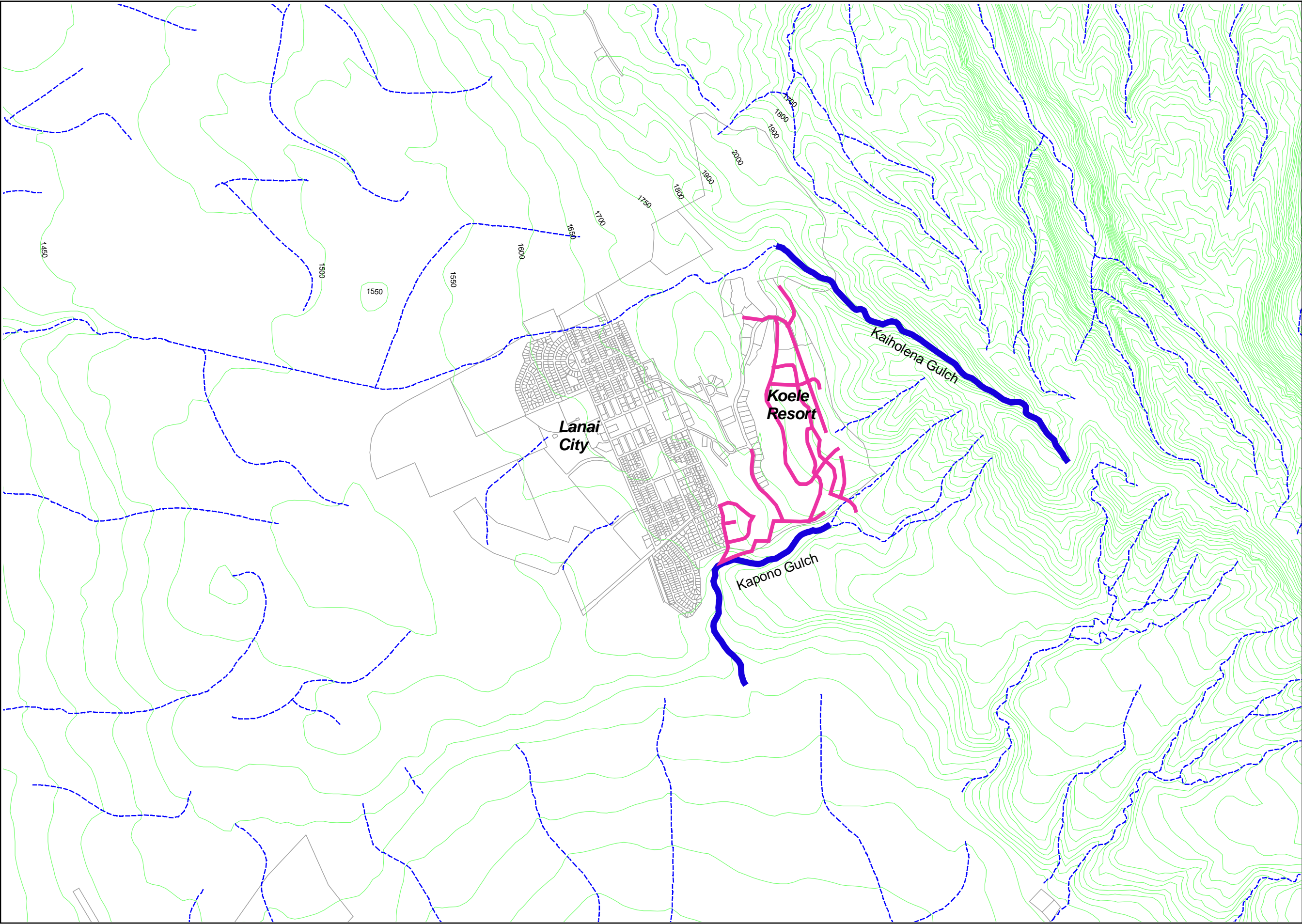
FIGURE 15
Molokai
Major Drainageways
and
Proposed Improvements

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements



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FIGURE 16
Lanai
Major Drainageways
and
Proposed Improvements

LEGEND

- Intermittent Stream
- Perennial Stream
- Major Drainline/Culvert
- Natural Drainageway
- 50-foot Contour
- Proposed Drainage Improvements

1000 0 1000 2000 Feet

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County of Maui
Infrastructure Assessment Update

Parking Assessment

Prepared for:

County of Maui
Planning Department

Prepared by:

Wilson Okamoto & Associates, Inc.

May 2003

TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	
I. INTRODUCTION	1
II. ASSESSMENT METHODOLOGY	1
A. EXISTING CONDITIONS	1
1. Wailuku	1
2. Kihei	2
3. Lahaina	2
4. Paia	2
5. Makawao	2
6. Park and Ride Facilities	2
B. FORECAST	3
III. WAILUKU	4
A. EXISTING SUPPLY	4
B. EXISTING DEMAND	4
C. FORECAST	4
D. IMPROVEMENTS	7
IV. KIHAI	8
A. EXISTING SUPPLY	8
B. EXISTING DEMAND	8
C. FORECAST	8
D. IMPROVEMENTS	11
V. LAHAINA	12
A. EXISTING SUPPLY	12
B. EXISTING DEMAND	12
C. FORECAST	12
D. IMPROVEMENTS	15
VI. PAIA	16
A. EXISTING SUPPLY	16
B. EXISTING DEMAND	16
C. FORECAST	16
D. IMPROVEMENTS	19
VII. MAKAWAO	20
A. EXISTING SUPPLY	20
B. EXISTING DEMAND	20
C. FORECAST	20
D. IMPROVEMENTS	23

VIII. PARK AND RIDES	24
A. EXISTING SUPPLY	24
B. EXISTING DEMAND	24
C. FORECAST	24
D. IMPROVEMENTS	25
Table 1 Parking Survey Schedule	3
Table 2 Wailuku Town Parking Forecast	7
Table 3 Kihei Area Parking Forecast	11
Table 4 Lahaina Town Parking Forecast	15
Table 5 Paia Town Parking Forecast	16
Table 6 Makawao Town Parking Forecast	20
Table 7 Park-n-Ride Forecast	24
Figure 1 Locations and Number of Stalls for the Public Parking Areas.....	5
Figure 2 Peak Parking Demand for Wailuku	6
Figure 3 Public Parking Areas Servicing Park Areas	9
Figure 4 Peak Parking Demand for Kihei Parks.....	10
Figure 5 Locations and Number of Stalls	13
Figure 6 Peak Parking Demand Lahaina Town	14
Figure 7 Public Parking Paia Town	17
Figure 8 Peak Parking Demand Paia Town	18
Figure 9 Location and Number of Stalls Makawao Town.....	21
Figure 10 Peak Parking Demand Makawao Town	22

EXECUTIVE SUMMARY

A. Introduction

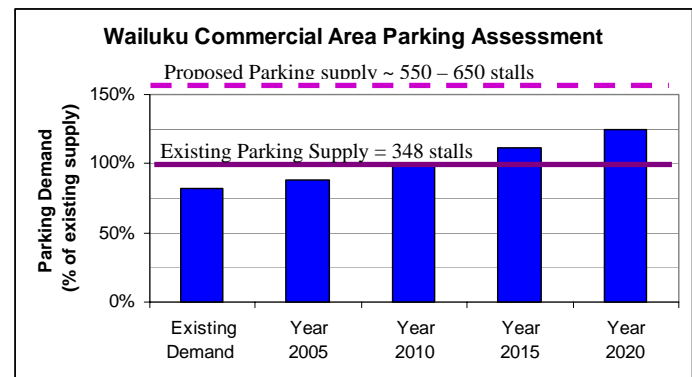
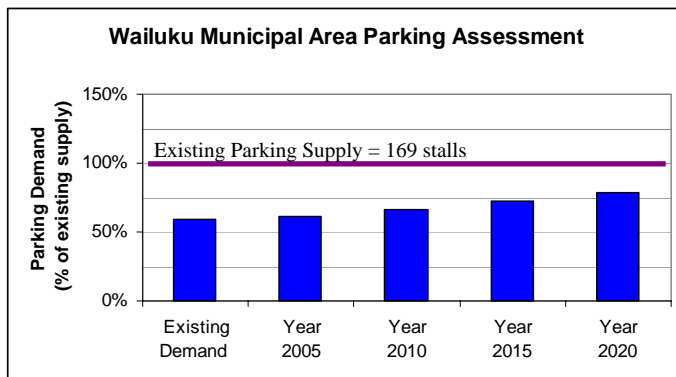
The parking assessment section examines on-and off-street public parking in the central town areas of Wailuku, Kihei, Lahaina, Makawao and Paia.

The existing public parking stall supply was inventoried, and demand for the stalls were surveyed during identified peak periods. Parking forecasts for five-year intervals between Year 2005 and Year 2020 were also projected based on socio-economic data compiled for the infrastructure study.

The following sections summarize the existing parking supply, existing demand, projected parking demand and the recommendations based on the future projections.

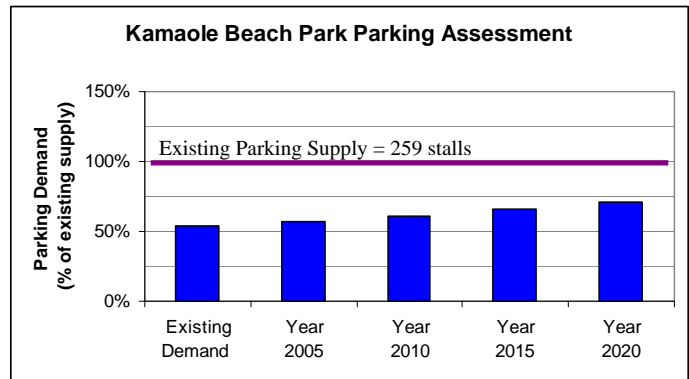
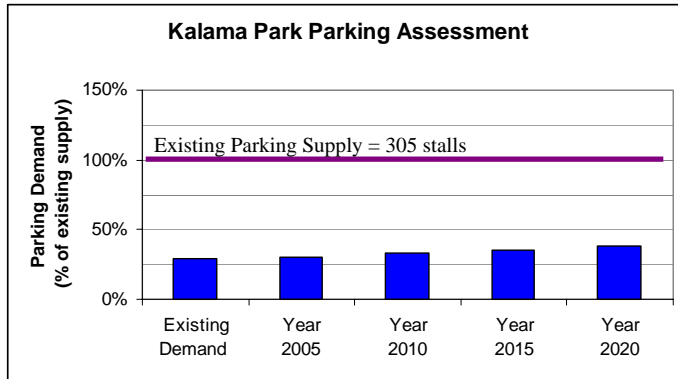
B. Wailuku

The municipal area parking capacity is projected to accommodate future parking demand. The parking demand within the commercial area is currently being addressed by a proposal to construct a 400 to 500 parking stall structure on the existing public parking lot bounded by Main Street, Church Street, Vineyard Street and Market Street.

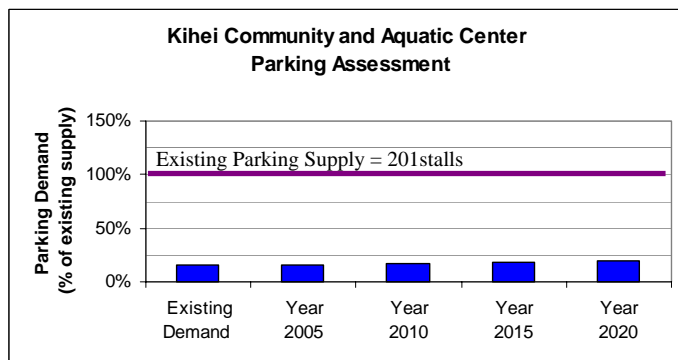


C. Kihei

The parking capacity for the Kihei area parks is projected to accommodate future parking demand. Recommendations focus on improvements to the existing parking, including, paving, striping and signing.

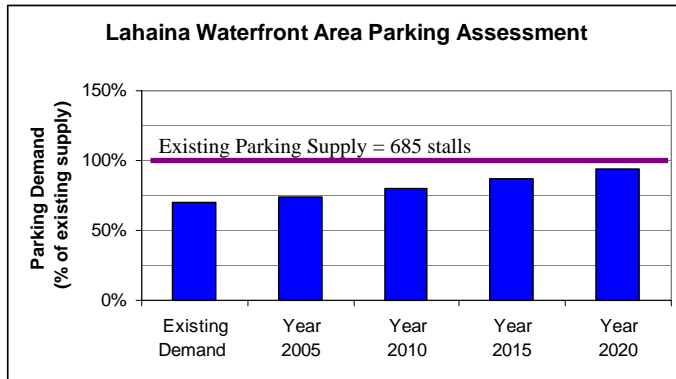


The parking capacity for the Kihei Community and Aquatic Center is projected to accommodate future parking demand. No parking improvements are recommended at this location.

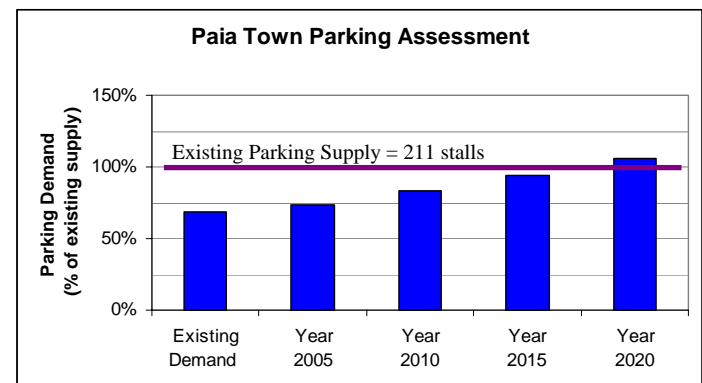
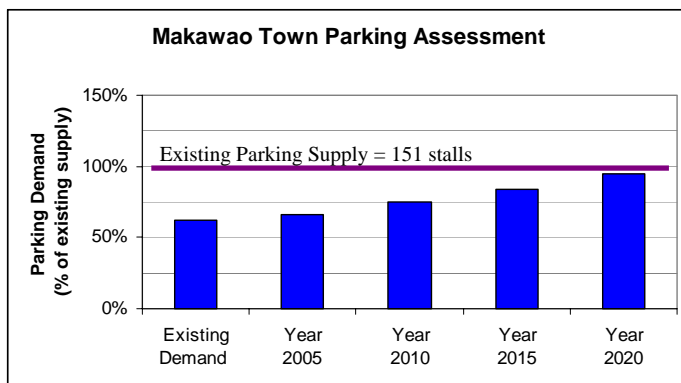


D. Lahaina

The Lahaina waterfront area will be nearing capacity by year 2020. Additional parking within the area may be necessary to accommodate future growth. The commercial area, located just mauka of the waterfront, may accommodate the parking demand, but will require further walking distance for waterfront patrons.

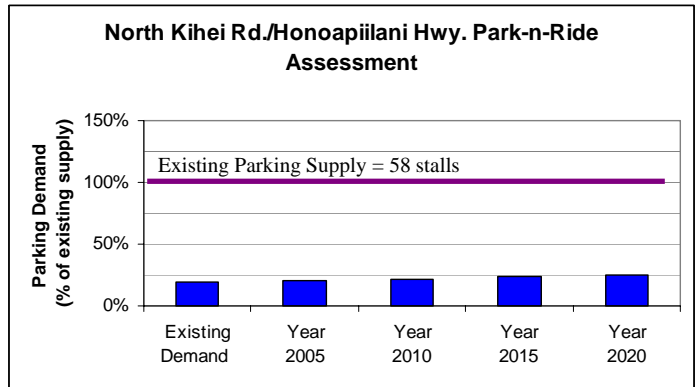
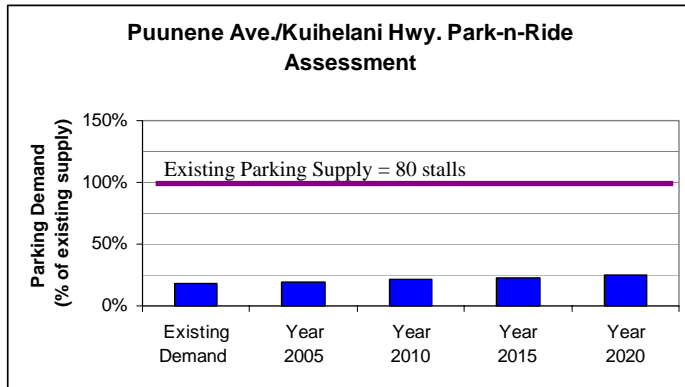
**E. Makawao Town and Paia Town**

Additional parking capacity for the Makawao Town should be considered by approximately year 2015 to accommodate the projected parking demand. Additional parking capacity for the Paia Town should also be considered by approximately year 2010 to accommodate the projected parking demand.



F. Park-n-Ride Facilities

Assuming no significant changes to travel patterns, the existing park-n-ride facilities are projected to have adequate capacity to accommodate year 2020 parking demand.



I. INTRODUCTION

This section presents an assessment of on- and off-street public parking in the central town areas of Wailuku, Kihei, Lahaina, Makawao and Paia. The emphasis of this assessment is on describing the existing parking conditions and providing recommendations for improvements based on future population projections.

Park-n-Ride facilities were also assessed as part of the infrastructure study. Existing parking conditions and recommendations based on future population projections are provided for these facilities.

The parking assessed for this study encompassed both the jurisdictions of the County of Maui and the State Department of Transportation.

II. ASSESSMENT METHODOLOGY

A. Existing Conditions

Past studies as well as field observations were used to identify the locations of existing public parking areas in the Wailuku, Kihei, Lahaina, Makawao and Paia town areas. Both on- and off-street parking was included in the assessment.

Based on conversations with the County of Maui, Department of Public Works, peak parking demand for specific area types were determined to occur as follows:

- Wailuku (commuter/work area) – weekdays
- Paia, Makawao (Tourist areas) – weekdays
- Lahaina, Kihei (Tourist/beach areas) – weekdays + weekends
- Park-n-Ride Facilities – weekdays

Parking surveys were performed in October 2002. For each parking location, parking capacity and demand was identified during the specified peak time periods. The number of recordings for each parking location was dependent on the time needed to survey the study area. A minimum of two survey passes were made for each study location with the exception of park and ride facilities for which one survey pass was made for each location. In addition, restrictions on parking, parking behavior and situations that may present safety hazards were observed. In the event that a parking area was full, an attempt was made to observe the overflow demand and destinations of these vehicles.

1. Wailuku

On- and off-street public parking locations including the County of Maui's municipal parking lot were surveyed. To capture commuter trips, Wailuku parking locations were surveyed during the work week in the morning (approximately 8:00 am to 9:00 am) and mid-day (approximately 11:00 am to 2:00 pm).

2. Kihei

On- and off-street public parking was surveyed for the areas serving the Kamaole Beach Parks I, II and III, Kalama Park and the Kihei Community and Aquatic Center. To capture both visitor and resident trips, study locations were surveyed both during the work week and the weekend during mid-day (approximately 11:00 am to 2:00 pm) and in the evening (approximately 4:00 pm to 5:00 pm).

3. Lahaina

On- and off-street public parking was surveyed throughout Lahaina town. To capture various activities in Lahaina, study locations were surveyed both during the work week and the weekend during mid-day (approximately 11:00 am to 2:00 pm) and in the evening (approximately 4:00 pm to 5:00 pm).

4. Paia

On- and off-street public parking was surveyed including two public parking lots within the lower Paia area. To capture visitor related trips to businesses in the Paia town area, study locations were surveyed on a weekday during mid-day (approximately 11:00 am to 2:00 pm) and in the afternoon (approximately 4:00 pm to 5:00 pm). The study time periods correspond with the area business service hours and visitor activity characteristics. The study periods were also verified with peak traffic characteristics from the State Department of Transportation's 24-hour traffic count data in the vicinity of Paia.

5. Makawao

On- and off-street public parking was surveyed including the public parking lot off of Makawao Avenue. To capture visitor related trips to businesses in the Makawao town area, study locations were surveyed on a weekday during mid-day (approximately 11:00 am to 2:00 pm) and in the afternoon (approximately 4:00 pm to 5:00 pm). The study time periods correspond with the area business service hours and visitor activity characteristics. The study periods were also verified with peak traffic characteristics from the State Department of Transportation's 24-hour traffic count data in the vicinity of Makawao.

6. Park and Ride Facilities

Similar to the methodology described above, the Puunene Avenue/Kuihelani Highway and Honoapiilani Highway/North Kihei Road facilities were surveyed. One survey was made to identify the capacity and demand of the facilities. To capture the majority of the commuter trips, this was performed on a weekday in the mid-morning. Park-n-Ride activity in the afternoon and evening hours were assumed to be minimal.

Table 1
Parking Survey Schedule

Location	Weekday Morning	Weekday Mid-Day	Weekday Afternoon	Weekend Mid-Day	Weekend Afternoon
Wailuku	✓	✓			
Kihei		✓	✓	✓	✓
Lahaina		✓	✓	✓	✓
Paia		✓	✓		
Makawao		✓	✓		
Park-n-Rides	✓				

B. Forecast

Parking demand was forecasted for 5-year intervals from Year 2005 to Year 2020. The Maui County Community Plan Update Program: Socio-Economic Forecast's baseline projections (SMS, May 2002) were used to derive the parking forecasts.

The basis of the growth rate was dependent on the area type. The Wailuku municipal area, Kihei parks, and Park-n-Ride facilities were based upon the resident and/or visitor population growth rates. The visitor/commercial areas were based upon service job projections by region.

Based on the growth projections provided in the socio-economic study, resident population and average visitor population increased at approximately the same rate, 1.5 percent per year. Therefore, the existing parking characteristics are not expected to change significantly.

All forecasts were based on the assumption that no significant modal shifts or parking legislation changes are made within the study period.

III. WAILUKU

Wailuku Town consists of two general areas; municipal and commercial. The municipal area is located south of Main Street, and is bounded by High Street, Church Street and Kaohu Street. The commercial area is primarily located north of Main Street and is bounded by High Street, Central Avenue and Vineyard Street. The area south of Main Street between Church Street, Market Street and Wells Street was also considered as part of the Wailuku Town area.

A. Existing Supply

Both the municipal and commercial areas contain a mixture of on-street parking as well as off-street public and private parking lots. The municipal area also has several metered public parking lots. The majority of the parking stalls within the town area are time restricted (1 Hr, 2 Hr or 12 Hr), and time limits are enforced by the Police Department. Figure 1 depicts the locations and number of stalls for the public parking areas within Wailuku Town. The supply numbers exclude restricted use stalls such as handicap accessible and commercial loading stalls.

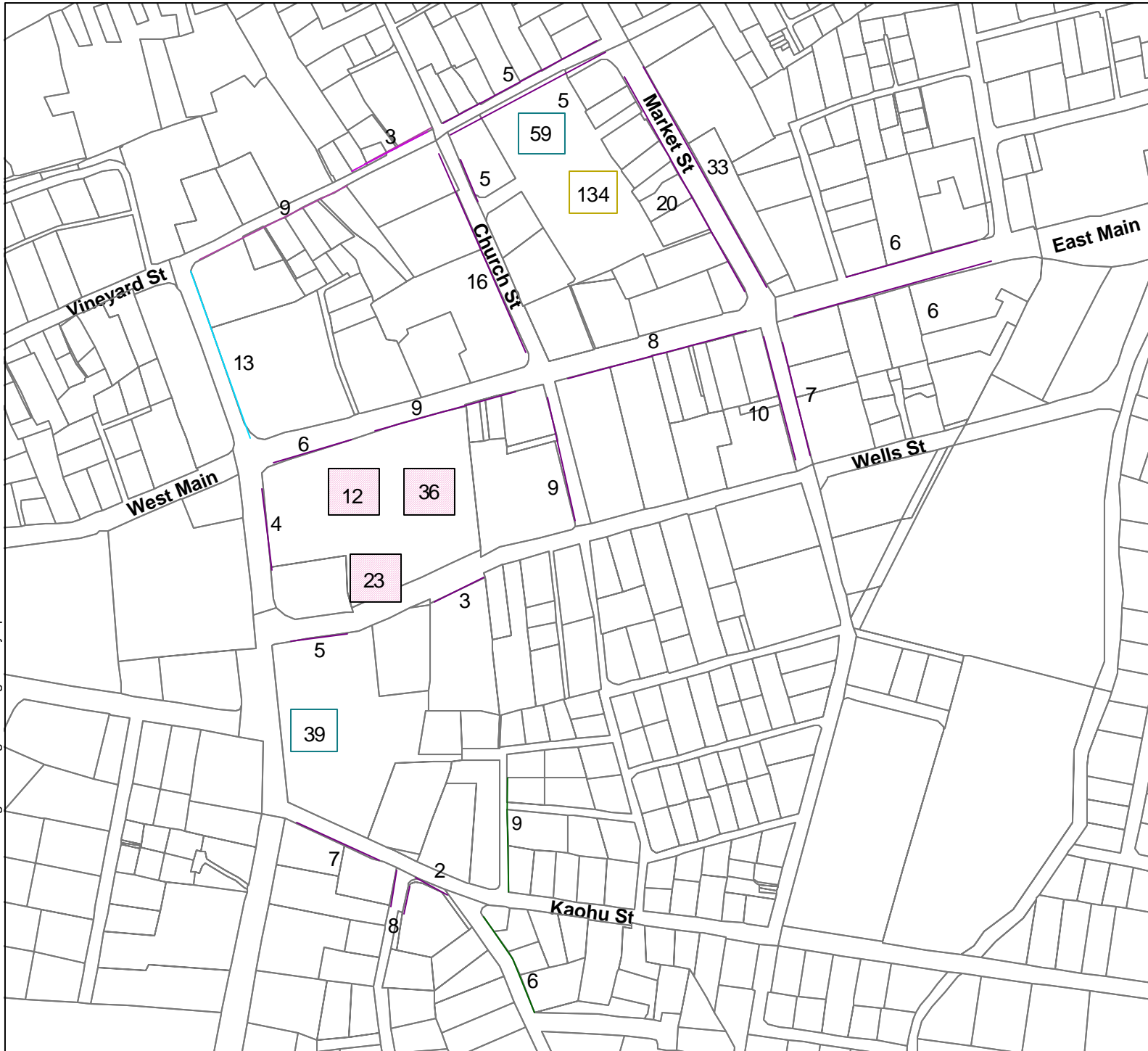
B. Existing Demand

The parking demand is fairly consistent throughout the day within the municipal area. Mid-day demand is slightly higher than the morning demand. Parking demand for the non-pay areas average approximately 75 percent of the capacity. The metered parking areas have a lower demand, approximately 40 percent. Adjacent neighborhood streets have no marked parking stalls or time restrictions. Kalua Road and Napua Street were both observed to have high parking usage, approximately 90 percent, although it was not apparent if the parking was being utilized by residents or people accessing the municipal area.

The commercial area parking demand is also fairly consistent throughout the day, with a slightly higher mid-day demand. Parking demand for the 1-hour and 2-hour parking stalls averages approximately 70 percent. The public parking lot north of Main Street bounded by Church Street, Vineyard Street and Market Street contains 12-hour parking stalls that were well utilized. The parking activity for these stalls occurred prior to the survey periods. The average occupancy for the long-term parking stalls was 98 percent. During the survey period, very low turnover was observed, and overflow demand for the long-term lot was not observed. Figure 2 depicts the peak parking demand for the Wailuku Town area.

C. Forecast

The parking demand for the municipal and commercial areas of Wailuku is shown in Table 2. The existing public parking supply includes all public parking stalls within the study area (free and pay parking). The existing demand includes the peak parking

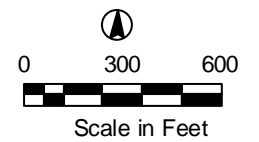
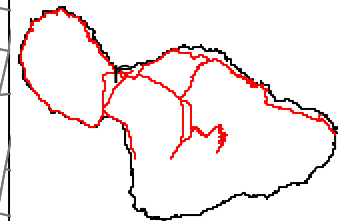


MAUI COMMUNITY PLAN UPDATE INFRASTRUCTURE ASSESSMENT

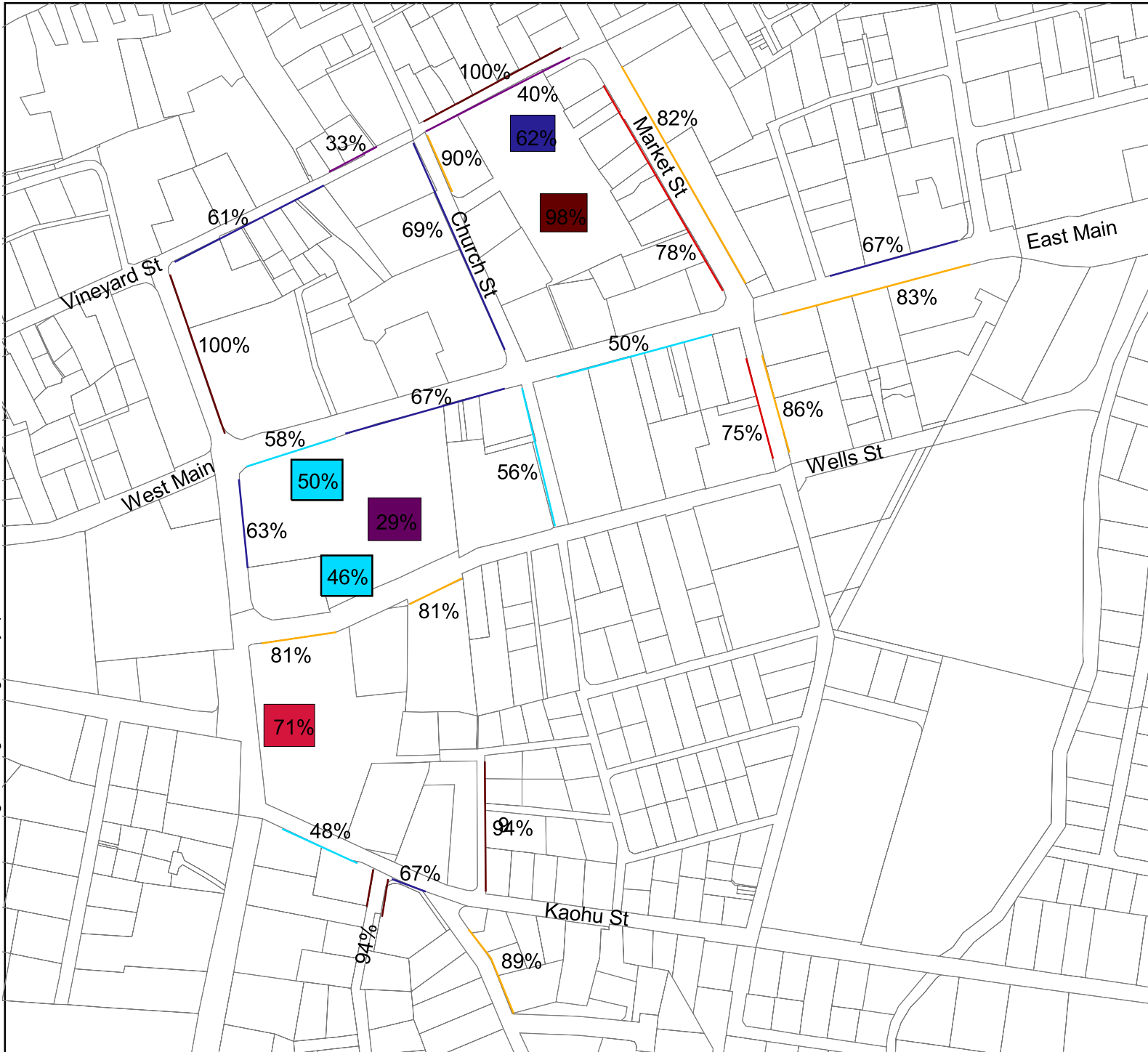
FIGURE 1
Wailuku
Public Parking
Supply
(No. of Stalls)

LEGEND

- On-Street Parking
- On-Street Parking (1 Hr)
- On-Street Parking (2 Hr)
- On-Street Parking (3 Hr)
- Off Street Parking
- Off Street Parking (3 Hr)
- Off Street Parking (Pay Lots)



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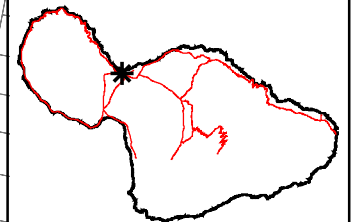


MAUI COMMUNITY PLAN UPDATE INFRASTRUCTURE ASSESSMENT

FIGURE 2
Wailuku
Public Parking
Demand
(Use in Percent)

LEGEND

- Demand 0-20% On-Street Parking
- Demand 21-40% On-Street Parking
- Demand 41-60% On-Street Parking
- Demand 61-70% On-Street Parking
- Demand 71-80% On-Street Parking
- Demand 81-90% On-Street Parking
- Demand 91-100% On-Street Parking
- Demand 0-20% Public Parking
- Demand 21-40% Public Parking
- Demand 41-60% Public Parking
- Demand 61-70% Public Parking
- Demand 71-80% Public Parking
- Demand 81-90% Public Parking
- Demand 91-100% Public Parking



0 100 200 400
Scale in Feet



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utilization during the survey periods. Growth rates are based on the Maui Community Plan Update Program: Socio-Economic Forecast data.

Table 2
Wailuku Town Parking Forecast
 Includes all public parking stalls (on-street, off-street municipal and pay lots)

Area	Existing Supply	Existing Demand	Growth Rate ¹	Forecast Need			
				2005	2010	2015	2020
<i>Wailuku</i>							
Municipal	169	99	1.6%	104	113	122	132
Commercial	348	284	2.4%	305	344	387	435

¹ Based on Maui County Community Plan Update Program: Socio-Economic Forecast, SMS, May 29, 2002. Exhibit R-13 Total Civilian Jobs, by Industry (Services). Exhibit I-1/I-17 Resident Population/Average Visitor Census.

The parking demand within the municipal area is currently less than 60 percent of the total capacity. The projected parking demand is expected to remain below 80 percent of the total capacity in the Year 2020.

The parking demand within the commercial area is currently over 80 percent of the existing capacity and will approach capacity levels by Year 2010.

D. Improvements

There are existing plans to expand the public parking lot north of Main Street bounded by Church Street, Vineyard Street and Market Street. The existing lot (approximately 200 stalls) would be replaced by a parking structure with an increased capacity to accommodate 400 to 500 parking stalls. An Environmental Assessment is currently being prepared for the parking structure.

With the additional parking capacity created by the proposed parking structure, the parking supply will be adequate to accommodate the projected parking demand. The forecasted Year 2020 demand would be between 67 to 80 percent of the capacity.

IV. KIHEI

The Kihei Town area is situated along South Kihei Road between North Kihei Road and Okolani Drive. Most of the commercial developments within Kihei provide off-street parking for their patrons. Thus, the focus of the parking assessment was on the major parks within the town; Kamaole Beach Park I, II and III, Kalama Park and the Kihei Community and Aquatic Center.

A. Existing Supply

A mixture of on-street parking as well as off-street public parking lots services the parks. The Kihei Community and Aquatic Center is served by an off-street parking lot on Lipoa Street. Figure 3 depicts the locations and number of stalls for the public parking areas servicing the park areas. The supply numbers exclude restricted use stalls such as staff, lifeguard and handicap accessible stalls.

B. Existing Demand

The parking demand for the parks was highest during the midday on the weekend. The Kamaole Beach Park I and III primary parking lots are heavily used and average approximately 95 percent occupancy. Both of these parks have a secondary/overflow lot on the mauka side of South Kihei Road, which were sparingly used. The on-street parking for all three of the Kamaole Beach Parks had lower utilization rates. Less than 50 percent of the on-street stalls were utilized.

Kalama Park has multiple lots as well as on-street parking. On average, the parking for Kalama Park was less than 30 percent. There were no organized sports activities during the survey period, however, no indication of parking capacity issues was received during discussions with the Maui County Traffic Section.

The Kihei Community and Aquatic Center had a demand of approximately 15 percent. There were also no organized sports activities or events during the survey period, however, no indication of parking capacity issues was received during conversations with the Maui County Traffic Section. Figure 4 depicts the peak parking demand for the Kihei park areas.

C. Forecast

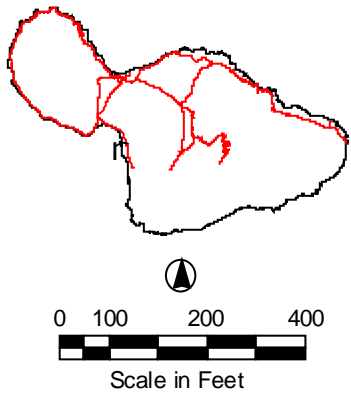
The parking demand for the Kamaole Beach Parks, Kalama Park and Community and Aquatic Center in Kihei is shown in Table 3. The existing public parking supply includes both on- and off-street public parking stalls in the vicinity of the parks. The existing demand includes the peak parking utilization during the survey periods. Growth rates are based on the Maui Community Plan Update Program: Socio-Economic Forecast data (SMS, May 2002).

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FIGURE 3
Kihei Public Parking
Supply
(No. of Stalls)

LEGEND

- Off-Street Parking Stalls
- On-Street Parking

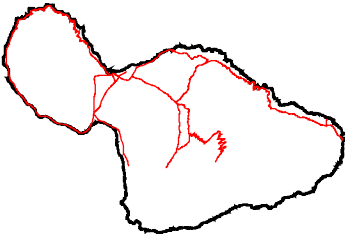


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PLAN UPDATE
INFRASTRUCTURE
ASSESSMENT

FIGURE 4
Kihei
Public Parking
Demand

LEGEND

- Demand 0-20% On-Street Parking
- Demand 21-40% On-Street Parking
- Demand 41-60% On-Street Parking
- Demand 61-70% On-Street Parking
- Demand 71-80% On-Street Parking
- Demand 81-90% On-Street Parking
- Demand 91-100% On-Street Parking
- Demand 0-20% Public Parking
- Demand 21-40% Public Parking
- Demand 41-60% Public Parking
- Demand 61-70% Public Parking
- Demand 71-80% Public Parking
- Demand 81-90% Public Parking
- Demand 91-100% Public Parking



1000 0 1000 Feet



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Table 3
Kihei Area Parking Forecast

Includes all public parking stalls for park areas (on-street & off-street)

Area	Existing Supply	Existing Demand	Growth Rate ¹	Forecast Need			
				2005	2010	2015	2020
<i>Kihei</i>							
Kalama Park	305	89	1.5%	93	100	108	116
Kamaole Beach Park	259	140	1.5%	147	158	170	184
Community Center	201	31	1.5%	32	35	38	41
¹ Based on Maui County Community Plan Update Program: Socio-Economic Forecast, SMS, May 29, 2002. Exhibit R-13 Total Civilian Jobs, by Industry (Services). Exhibit I-1/I-17 Resident Population/Average Visitor Census.							

The parking demand for Kalama Park is currently less than 30 percent of the total capacity. The projected parking demand is expected to remain below 40 percent of the total capacity in the Year 2020.

The parking demand for the Kamaole Beach Parks is currently 55 percent of the existing capacity and will be slightly over 70 percent in the Year 2020.

The parking demand for the Kihei Community and Aquatic Center is currently 15 percent of the existing capacity and will be slightly over 20 percent in the Year 2020.

D. Improvements

The existing parking capacity for the Kihei parks is projected to remain adequate to accommodate the projected Year 2020 parking demand. The proposed recommendations focus on improvement of the existing parking within the area.

The on-street parking south of Kamaole Beach Park III occurs along the makai roadway shoulder. The shoulder appears to be eroding, and may need to be reinforced/paved to maintain parking activities.

The primary off-street parking lot for the Kamaole Beach Park I is relatively small, and the overflow parking on the mauka side of South Kihei Road is used frequently. The mauka lot should be paved and striped to provide adequate capacity and improve safety for vehicles within the lot. Adequate signage should also be provided on South Kihei Road and Alanui Ke Alii Street to direct park users to the overflow parking area.

The overflow lot for Kamaole Beach Park III is not clearly visible from South Kihei Road, and lacks directional signage. Adequate signage should be provided on South Kihei Road and Keonekai Street to direct park users to the overflow parking area.

V. LAHAINA

The Lahaina Town area is situated along Front Street between Shaw and Papalaua streets. The town area consists mainly of local and tourist related commercial businesses and restaurants. Additionally, major waterfront/harbor activities occur from the harbor area.

Generally, the individual businesses within Lahaina do not provide parking for their patrons/employees. Centralized municipal and pay lots and on-street parking comprise the parking supply within Lahaina.

A. Existing Supply

A mixture of on-street parking as well as off-street municipal and pay parking lots services the town. The on-street and municipal lots are free and are limited to 3 hour parking. The fees for the pay lots vary, and are usually based on hourly rates. Figure 5 depicts the locations and number of stalls for the public parking areas servicing the Lahaina Town area. The supply numbers exclude restricted use stalls such as handicap accessible and commercial loading stalls.

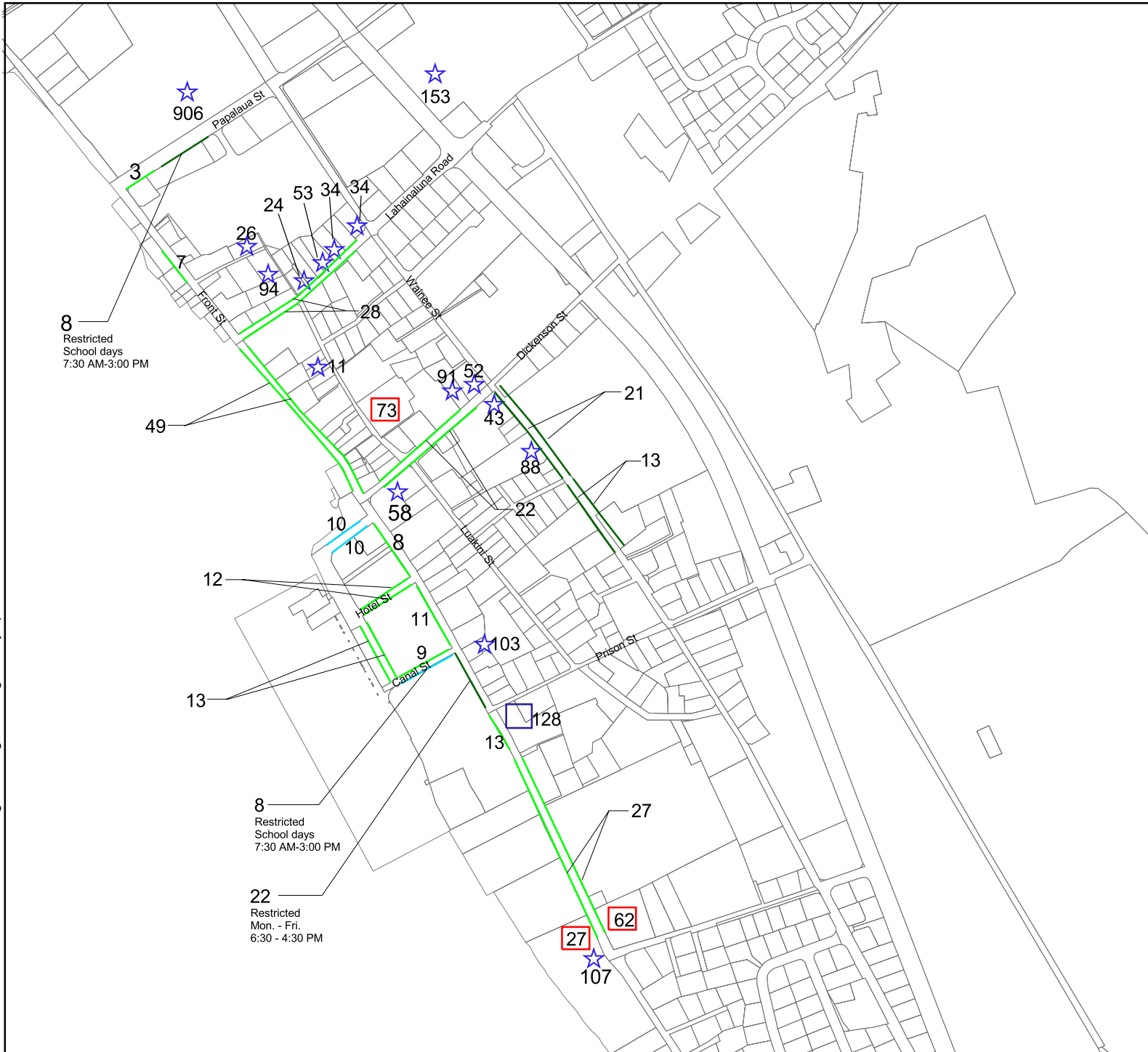
B. Existing Demand

The parking demand near the harbor/waterfront is highest on the weekend during both the mid-day and afternoon. The overall parking demand is approximately 70 percent of capacity. The free parking areas have almost an 85 percent demand, while the pay lots have a 40 percent demand. The on-street parking in the immediate vicinity of the harbor was observed as having 100 percent demand.

Near the commercial areas, mauka of Front Street, parking demand was generally higher during the weekday. The existing parking demand for the area was slightly under 50 percent. Figure 6 depicts the peak parking demand for the Lahaina Town area.

C. Forecast

The parking demand for Lahaina is shown in Table 4. The existing public parking supply includes all public parking stalls within the study area (free and pay parking). The existing demand includes the peak parking utilization during the survey periods. Growth rates are based on the Maui Community Plan Update Program: Socio-Economic Forecast data (SMS, May 2002).

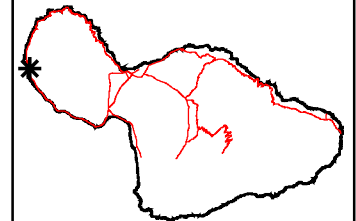


MAUI COMMUNITY PLAN UPDATE INFRASTRUCTURE ASSESSMENT

FIGURE 5
Lahaina
Public Parking
Supply
(No. of Stalls)

LEGEND

- On-Street Parking (1 Hr)
- On-Street Parking (2 Hr)
- On-Street Parking (3 Hr)
- Off Street Parking
- Off Street Parking (3 Hr)
- Off Street Parking (Pay Lots)



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Table 4
Lahaina Town Parking Forecast

Includes all public parking areas (on-street, off-street municipal and pay lots)

Area	Existing Supply	Existing Demand	Growth Rate ¹	Forecast Need			
				2005	2010	2015	2020
<i>Lahaina</i>							
Waterfront	685	483	1.6%	506	548	593	642
Commercial	1767	834	1.6%	875	947	1025	1110

¹ Based on Maui County Community Plan Update Program: Socio-Economic Forecast, SMS, May 29, 2002. Exhibit R-13 Total Civilian Jobs, by Industry (Services). Exhibit I-1/I-17 Resident Population/Average Visitor Census.

The parking demand within the waterfront/harbor area is currently just over 70 percent of the total capacity. The projected parking demand is expected to approach capacity levels by Year 2020.

The parking demand within the commercial area is currently less than 50 percent of the existing capacity and will be slightly over 60 percent in the Year 2020.

D. Improvements

The parking demand in the waterfront/harbor vicinity will be nearing capacity by Year 2020. Additional parking within the area may be necessary to accommodate the projected growth. The commercial area is located just mauka of the waterfront, and could provide the necessary capacity, but would require slight inconvenience to patrons due to longer walking distances.

VI. PAIA

The Paia Town area is situated around the intersection of Hana Highway and Baldwin Avenue. The town area consists mainly of small local and tourist related commercial businesses and restaurants. The supply numbers exclude restricted use stalls such as handicap accessible and commercial loading stalls.

A. Existing Supply

A mixture of parallel and angled on-street parking is provided on Hana Highway and Baldwin Avenue. The on-street parking along Hana Highway is limited to 2 hours, and the parking along Baldwin Avenue is limited to 1 hour. Two municipal lots are provided within the town. The municipal lot off of Baldwin Avenue restricts overnight parking activities. Figure 7 depicts the locations and number of stalls for the public parking areas servicing the Paia Town area.

B. Existing Demand

The demand for parking within Paia Town remains consistently high throughout the day. The Hana Highway on-street parking averages over 80 percent demand. The on-street parking on Baldwin Avenue also remains high at over 90 percent demand. The municipal lot off of Baldwin Avenue was observed to be completely full during all survey periods, while the lot off of Hana Highway had reserve capacity with a demand of slightly over 30 percent. Figure 8 depicts the peak parking demand for the Paia Town area.

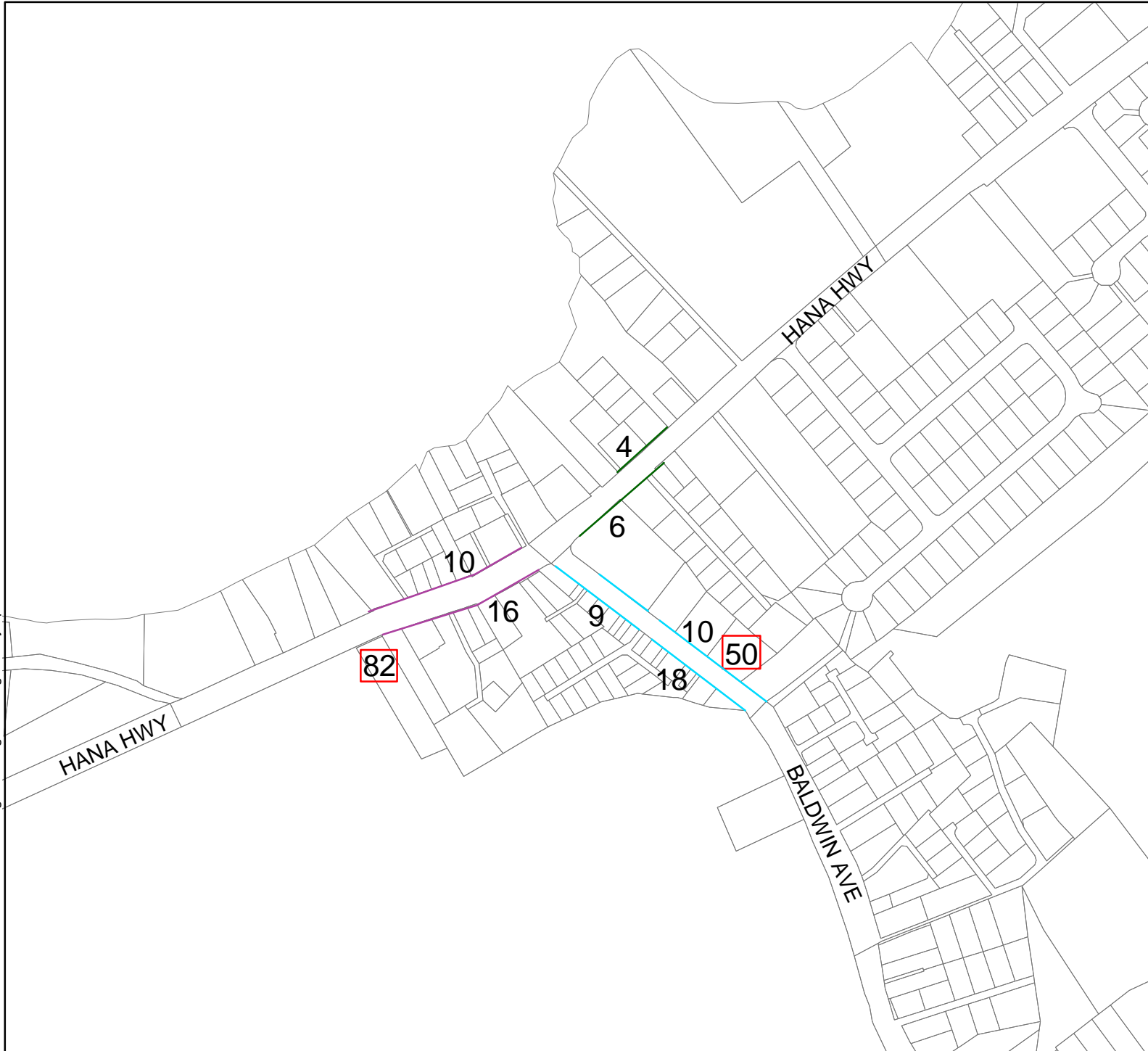
C. Forecast

The parking demand for the town of Paia is shown in Table 5. The existing public parking supply includes all public parking stalls within the study area. The existing demand includes the peak parking utilization during the survey periods. Growth rates are based on the Maui Community Plan Update Program: Socio-Economic Forecast data (SMS, May 2002).

Table 5
Paia Town Parking Forecast
Includes all public parking areas (on-street & off-street)

Area	Existing Supply	Existing Demand	Growth Rate ¹	Forecast Need			
				2005	2010	2015	2020
<i>Paia</i>	211	145	2.4%	156	176	198	223

¹ Based on Maui County Community Plan Update Program: Socio-Economic Forecast, SMS, May 29, 2002. Exhibit R-13 Total Civilian Jobs, by Industry (Services). Exhibit I-1/I-17 Resident Population/Average Visitor Census.

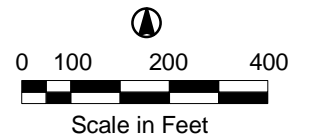
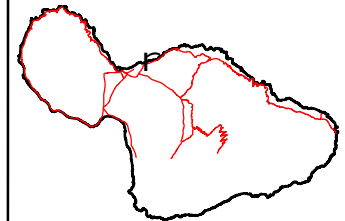


MAUI COMMUNITY PLAN UPDATE INFRASTRUCTURE ASSESSMENT

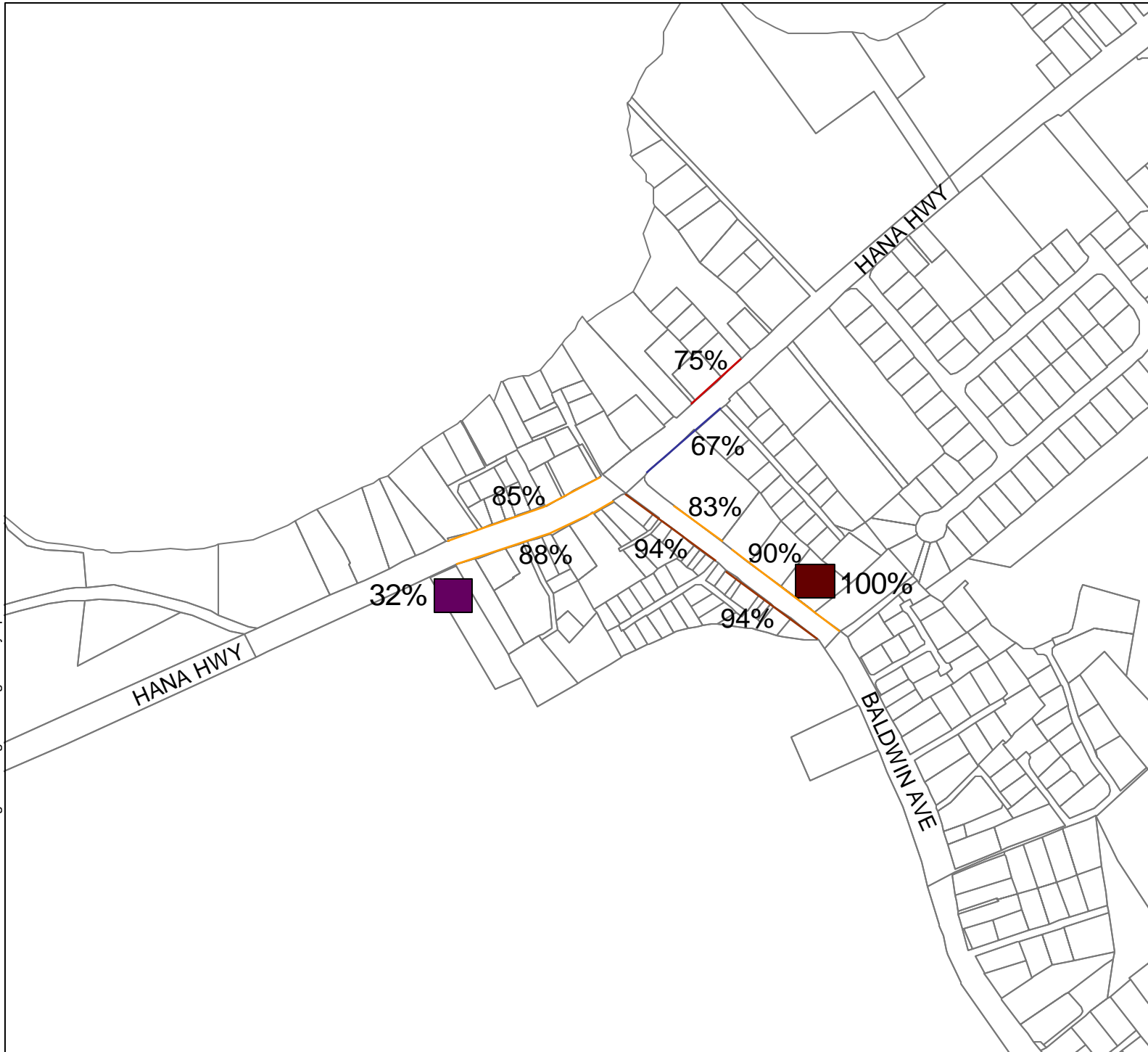
FIGURE 7
Paia
Public Parking
Supply
(No. of Stalls)

LEGEND

- On-Street Parking (1 Hr)
- On-Street Parking (2 Hr)
- On-Street Parking (3 Hr)
- Off Street Parking
- Off Street Parking (3 Hr)
- Off Street Parking (Pay Lots)



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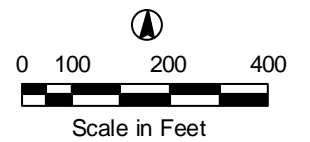
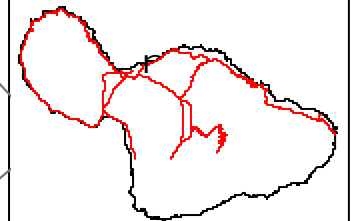


MAUI COMMUNITY PLAN UPDATE INFRASTRUCTURE ASSESSMENT

FIGURE 8
Paia
Public Parking
Demand
(Use in Percent)

LEGEND

- Demand 0-20% On-Street Parking
- Demand 21-40% On-Street Parking
- Demand 41-60% On-Street Parking
- Demand 61-70% On-Street Parking
- Demand 71-80% On-Street Parking
- Demand 81-90% On-Street Parking
- Demand 91-100% On-Street Parking
- Demand 0-20% Public Parking
- Demand 21-40% Public Parking
- Demand 41-60% Public Parking
- Demand 61-70% Public Parking
- Demand 71-80% Public Parking
- Demand 81-90% Public Parking
- Demand 91-100% Public Parking



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The parking demand within the town currently averages approximately 75 percent of the total capacity. The projected parking demand is expected to be nearing the parking capacity by 2015, and surpass the total parking capacity by the Year 2020 by approximately 5 percent.

D. Improvements

Additional parking within Paia Town should be considered by approximately Year 2010 to accommodate the projected parking demand. The current parking survey indicates that the parking demand is significantly higher at the Baldwin Avenue municipal lot, and expansion of this lot or provision of additional parking in the vicinity may be desirable.

VII. MAKAWAO

The Makawao Town area is situated around the intersection of Makawao Avenue and Baldwin Avenue. The town area consists mainly of small local and tourist related commercial businesses and restaurants.

A. Existing Supply

Baldwin Avenue has a mixture of on-street parallel and angle parking, while Makawao Avenue has four parallel parking stalls. All on-street parking is limited to 2 hours. The municipal parking lot off of Makawao Avenue had no time restrictions. The supply numbers exclude restricted use stalls such as handicap accessible and commercial loading stalls. Figure 9 depicts the locations and number of stalls for the public parking areas servicing the Makawao Town area.

B. Existing Demand

The demand for parking within Makawao Town remains consistent throughout the day. The on-street parking averages over 75 percent usage. The municipal lot off of Makawao Avenue had an average demand of slightly over 50 percent. Figure 10 depicts the peak parking demand for the Makawao Town area.

C. Forecast

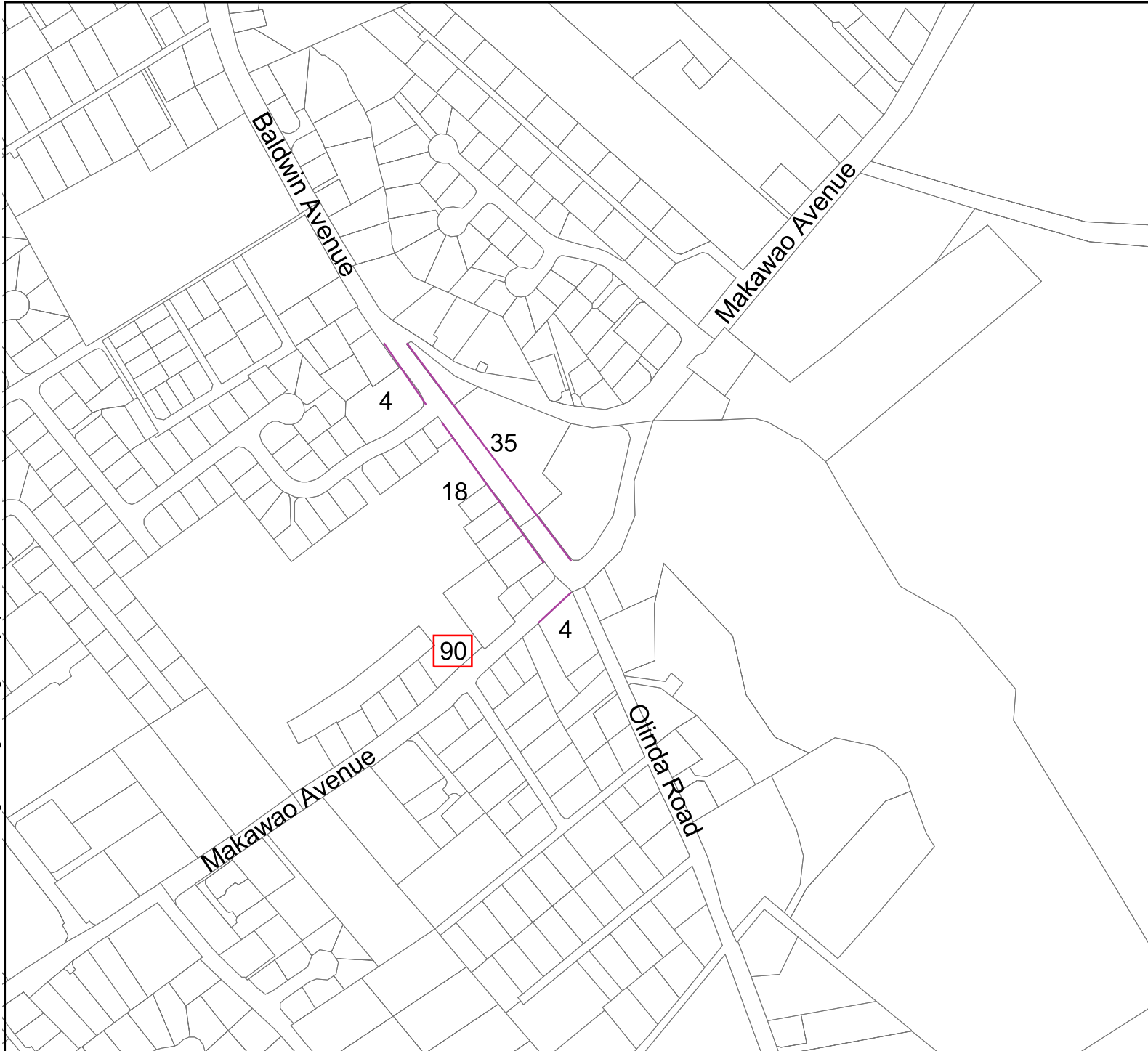
The parking demand for the town of Makawao is shown in Table 6. The existing public parking supply includes all public parking stalls within the study area. The existing demand includes the peak parking demand during the survey periods. Growth rates are based on the Maui Community Plan Update Program: Socio-Economic Forecast data (SMS, May 2002).

Table 6
Makawao Town Parking Forecast
Includes all public parking areas (on-street & off-street)

Area	Existing Supply	Existing Demand	Growth Rate ¹	Forecast Need			
				2005	2010	2015	2020
<i>Makawao</i>	151	93	2.4%	100	113	127	143

¹ Based on Maui County Community Plan Update Program: Socio-Economic Forecast, SMS, May 29, 2002. Exhibit R-13 Total Civilian Jobs, by Industry (Services). Exhibit I-1/I-17 Resident Population/Average Visitor Census.

The parking demand within the town currently averages approximately 62 percent of the total capacity. The projected parking demand is expected to be approaching the total parking capacity by the Year 2020.

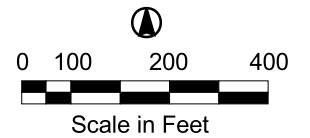
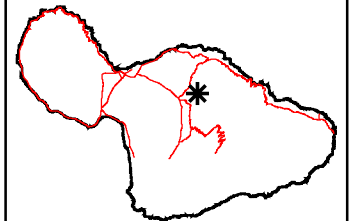


MAUI COMMUNITY PLAN UPDATE INFRASTRUCTURE ASSESSMENT

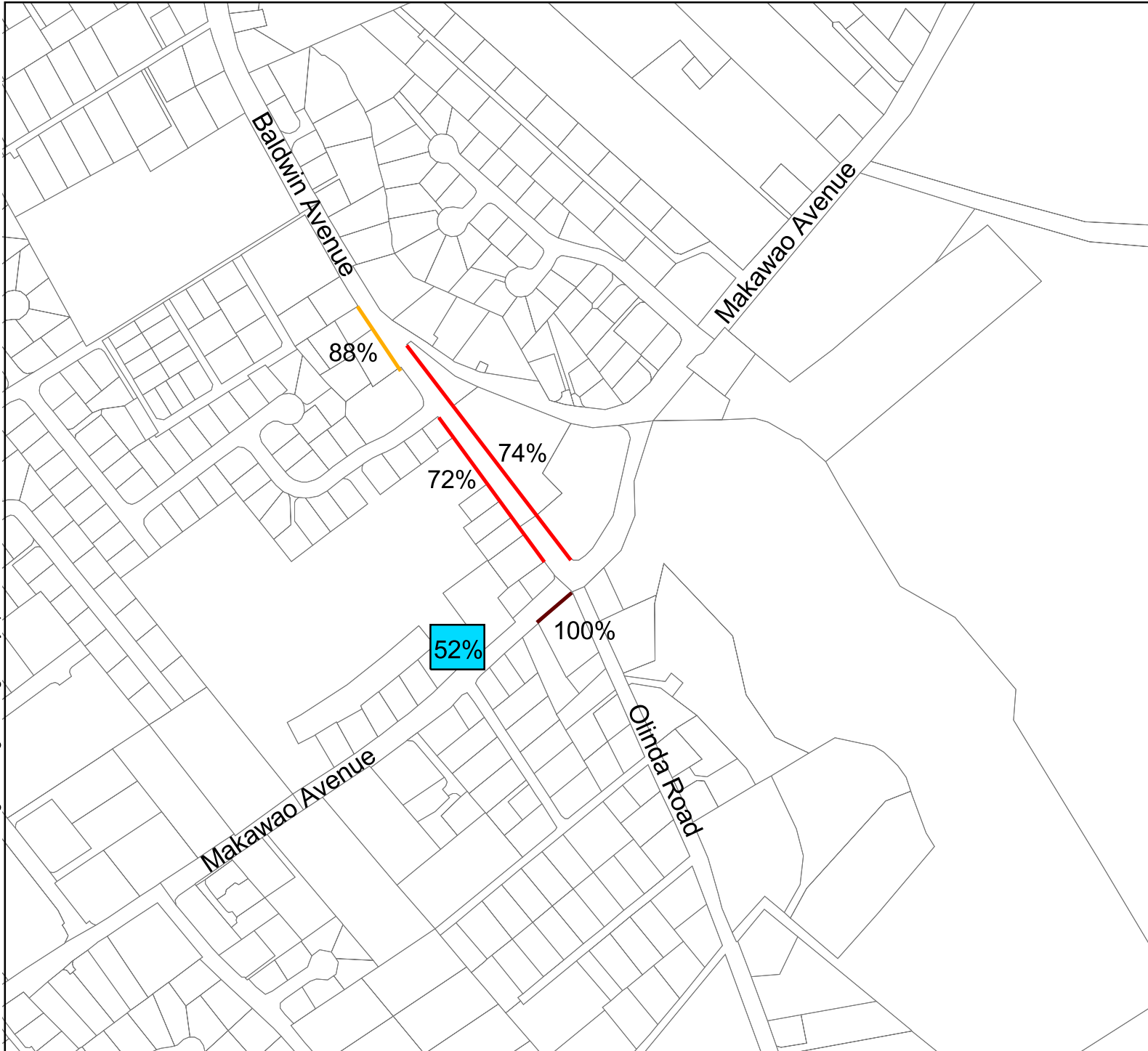
FIGURE 9
Makawao
Public Parking
Supply
(No. of Stalls)

LEGEND

- On-Street Parking
- On-Street Parking (1 Hr)
- On-Street Parking (2 Hr)
- On-Street Parking (3 Hr)
- Off Street Parking
- Off Street Parking (3 Hr)
- Off Street Parking (Pay Lots)



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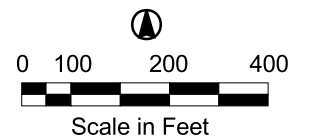
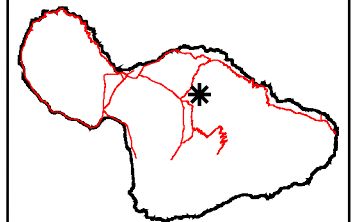


MAUI COMMUNITY PLAN UPDATE INFRASTRUCTURE ASSESSMENT

FIGURE 10
Makawao
Public Parking
Demand
(Use in Percent)

LEGEND

- Demand 0-20% On-Street Parking
- Demand 21-40% On-Street Parking
- Demand 41-60% On-Street Parking
- Demand 61-70% On-Street Parking
- Demand 71-80% On-Street Parking
- Demand 81-90% On-Street Parking
- Demand 91-100% On-Street Parking
- Demand 0-20% Public Parking
- Demand 21-40% Public Parking
- Demand 41-60% Public Parking
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- Demand 71-80% Public Parking
- Demand 81-90% Public Parking
- Demand 91-100% Public Parking



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D. Improvements

Additional parking within Makawao Town should be considered by approximately Year 2015 to accommodate the projected parking demand.

VIII. PARK AND RIDES

The park-and-ride facilities surveyed were located at the intersections of North Kihei Road/Honoapiilani Highway and Puunene Avenue/Kuihelani Highway. The park-n-ride facilities service carpool and private shuttle activities.

A. Existing Supply

The North Kihei Road/Honoapiilani Highway facility consists of a 61-stall paved parking lot including 3 accessible stalls. A passenger pick-up/drop-off area is provided near the entrance to the lot.

The Puunene Avenue/Kuihelani Highway Avenue lot was surveyed during the construction of the Kuihelani Highway improvement project, thus the park-n-ride facility was relocated to the north-east side of the intersection and consisted of a temporary graded gravel parking lot. The capacity of the gravel lot was estimated to be 80 vehicles.

B. Existing Demand

The demand for both park-n-ride facilities was low. Eleven vehicles were observed in the North Kihei Road/Honoapiilani Highway facility. Fifteen vehicles were observed in the North Puunene Avenue/Kuihelani Highway facility. The observed usage was less than 20 percent of the capacity.

C. Forecast

The parking demand for the Park-n-Ride facilities is shown in Table 7. The existing public parking supply includes all public parking stalls within park-n-rides. The existing demand includes the peak parking utilization during the survey periods. Growth rates are based on the Maui Community Plan Update Program: Socio-Economic Forecast data.

Table 7
Park-n-Ride Parking Forecast

Area	Existing Supply	Existing Demand	Growth Rate ¹	Forecast Need			
				2005	2010	2015	2020
N.Kihei Rd/ Honoapiilani Hwy	58	11	1.6%	12	12	14	15
Puunene Ave/ Kuihelani Highway	~80	15	1.6%	16	17	18	20

¹ Based on Maui County Community Plan Update Program: Socio-Economic Forecast, SMS, May 29, 2002. Exhibit R-13 Total Civilian Jobs, by Industry (Services). Exhibit I-1/I-17 Resident Population/Average Visitor Census.

The parking demand at the park-n-rides is currently less than 20 percent of the total capacity. The projected parking demand is expected to increase to 25 percent of the total capacity in the Year 2020.

D. Improvements

Assuming that no significant changes to travel patterns occurs, the existing park-n-ride facilities are projected to have adequate capacity to accommodate Year 2020 parking demand. The facilities may need to be re-evaluated if commuter modal changes are implemented, including transportation demand management programs and/or increased public transit.

***County of Maui
Infrastructure Assessment Update***

Electrical Systems

Prepared for:

***County of Maui
Planning Department***

Prepared by:

***Wilson Okamoto & Associates, Inc.
Morikawa & Associates***

May 2003

TABLE OF CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	
EXECUTIVE SUMMARY	1
I. INTRODUCTION - ELECTRICAL	1
II. DEMAND AND GENERATION.....	2
A. Off-Peak Demand and Generation.....	2
B. On-Peak Demand and Generation	4
1. Shoulder Peak Demand.....	4
2. Priority Peak Demand	5
C. Demand Growth.....	6
D. Demand Differential	7
III. EXISTING FACILITIES.....	9
A. Generating Facilities	9
B. Generating Facilities Growth.....	11
C. Existing MECO Transmission Grid.....	12
D. Transmission Grid Growth	12
IV. SUPPLY –SIDE AND DEMAND-SIDE MANAGEMENT	13
A. Supply-Side Management.....	13
B. Demand-Side Management.....	13
V. PROJECTED ELECTRICAL DEMAND.....	15
A. Historical Projections.....	15
B. Linear Projections	15
C. Nonlinear Projections	17
D. Future Actions.....	18
VI. INTRODUCTION – COMMUNICATION SYSTEMS	28
VII. EXISTING FACILITIES.....	28
VIII. FUTURE COMMUNICATION SYSTEM.....	29
IX. INTRODUCTION - CABLE	30
X. RESIDENTIAL AND COMMERCIAL DEMAND	30
XI. EXISTING SYSTEM.....	31
A. Design	31
B. Facilities.....	31
C. Capacity	32

XII. Conclusions - Cable 32**LIST OF FIGURES**

	<u>Page</u>
Figure 1 Typical Daily System Demand Profile	2
Figure A-1 Maui Transmission Line Diagram	22
Figure A-2 Molokai Transmission Line Diagram	23
Figure A-3 Lanai Transmission Line Diagram	24
Figure A-5 Low Electric Demand Versus Future Generating Capacity	25
Figure A-6 Base Electric Demand Versus Future Generating Capacity	26
Figure A-7 High Electric Demand Versus Future Generating Capacity	27

LIST OF TABLES

	<u>Page</u>
Table 1 Differential Between Minimum Demand and Day Peak Demand	8
Table 2 2001 Kahului Plant Installed Generation Capacity	10
Table 3 2001 Maalaea Plant Installed Generation Capacity	10
Table 4 Projected Maui Electric Power Demand	16
Table A-1 1990-2000 Power Demand	19
Table A-2 2002-2020 Power Demand	19
Table A-3 Historical Average Visitor Census and Resident Population	20
Table A-4 Average Visitor Census and Resident Population Projections	21
Table 5 Potential Customers	30

LIST OF CHARTS

	<u>Page</u>
Chart 1 Maui Baseload Demand	3
Chart 2 Maui Shoulder Peak Demand.....	5
Chart 3 Maui Priority Peak Demand	6
Chart 4 Minimum, Day Peak & Evening Peak Demand	7
Chart 5 MECO Generating Capacity Versus Predicted Peak Demands	18

LIST OF EXHIBITS

	<u>Page</u>
Exhibit A Maui CATV Delivery System	33

EXECUTIVE SUMMARY

A. Introduction

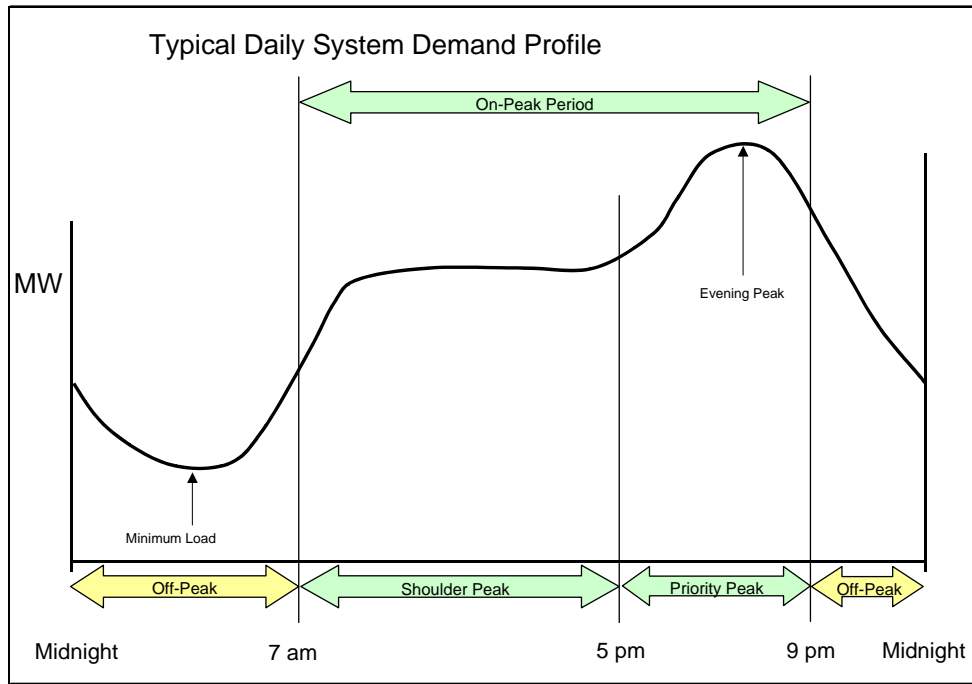
This section presents an assessment of the existing electrical power generation, and transmission systems as well as future plans and requirements for meeting the electrical demands of the island through 2020.

Inasmuch as electrical power is supplied by Maui Electric Company (MECO), which is a private entity regulated by the Public Utilities Commission (PUC), future planning of electrical facilities is not a County function. Thus, this report is intended to provide an overview of major planning issues concerning electrical power on the island as opposed to specifying needed improvements.

It should be noted that the County is participating in the Integrated Resource Planning (IRP) process being conducted by MECO. The IRP will provide much more in-depth examination of planning issues for Maui's electrical needs. Required by the PUC for all energy utilities in Hawaii, the IRP is a 20 year plan including sales and demand forecasting, supply-side alternatives for producing power, demand-side alternatives for energy efficiency and conservation, and integration. The IRP process will include public participation and public information. Through the IRP process, MECO will develop its least cost plan, which includes consideration of environmental and social costs as well as economic costs. MECO submitted its first IRP plan in December 1993 that was approved in May 1996 and reevaluated in 1997 and 1998. On May 31, 2000, MECO filed a second IRP plan for approval and evaluation with the Hawaii PUC.

B. Demand and Generation

Demand for electricity in this study is divided into two periods: on-peak demand and off-peak demand. The grouping of on-peak demand is further categorized into shoulder peak demand and priority peak demand. Demand is evaluated this way due to the daily cyclical pattern of electric power consumption. This cyclical pattern permits the electric power company to utilize its generating capacity in the lowest cost manner given all levels of demand.

Figure 1**Typical Daily System Demand Profile****1. On-Peak Demand and Generation**

During the latter half of the decade, the percentage increase for electrical demand slightly declined. The yearly evening peak demand growth rate for the years 1995-2000 was approximately 1.7 percent. In comparison, the average growth rate was 2.9 percent throughout that particular decade. Although the recent amount of electrical demand suggests that the electrical demand is decreasing, it is unlikely that such a trend will be sustainable indefinitely.

2. Off-Peak Demand and Generation

According to the 1992 Infrastructure Assessment, Maui County experienced an annual growth in baseload demand of approximately 2 MW per year at a growth rate of 8.6 percent. This 1992 testing period from 1979-1990 yielded a total increase in baseload demand of 25 MW. More recently, the baseload demand on Maui increased by over 24 MW during the years 1990-2000 for an average minimum demand growth rate of 4.1 percent. By these figures, it can be determined that historically baseload demand has followed a fairly linear pattern, and it will possibly follow a similar pattern in the future.

3. Demand Differential

Since 1990, there has been an increase in the difference between minimum load demand and day peak demand from 78.2 MW to 100 MW. Recent trends had shown a reduction in annual increase of differential, but the results from 2000 continued the upward increase between baseload demand and day peak demand.

The minimum load demand increased by 24.1 MW during the 1990-2000 period. In comparison, the day peak load nearly doubled that amount. In that same ten-year span, the day peak load expanded to 45.9 MW. With this difference in demand loads, it gives insight into what type of generating units should be installed in the future. If this trend continues, the units that should be installed should be capable of both baseload and cycling generation. Proportionally, there was a greater amount of cycling generation that needed to be installed during the years 1990-2000. Based on continuing trends, day peak load and evening peak load will be over two times as great as the baseload demand. Given these circumstances, the installed capacity should be broken down into the following categories. In 2020, the expected increase in baseload demand is 40.6 MW. Day peak load will increase by 82.3 MW. Based on these figures, there should be a minimum of 41 MW installed of baseload generation. To meet the day peak load and to compensate for an unexpected increase in baseload generation, a minimum of 83 MW of cycling units should be installed. These cycling units should have a certain percentage that can convert their cycling generation into baseload generation given fluctuations in electricity demand. Lastly, a minimum of 60 MW of peaking units will have to be installed to meet the future evening peak demands.

C. Existing Facilities

The installed generating capacity that are currently owned and operated by MECO on the island of Maui is 212.90 MW. This capacity is divided between the Maalaea Generating Station that has a reserve capability of 175.30 MW and the Kahului Generating Station that has a reserve capability of 37.60 MW. The total generating capacity from these stations are supplied by 26 generating units at two power plant sites and one substation site on Maui. Additional power from Hawaiian Commercial and Sugar (HC&S) from the Puunene Mill supplements the total installed generating capacity of MECO.

To meet the past demand growth on the island of Maui in the 1990-2000 period, MECO installed a total of 100 MW of additional generating capacity. If unit M-19, a combustion turbine unit that is currently used for peak demand, is included in the total generating capacity, the total generating capacity for MECO will be 250.1 MW.

Future baseload unit additions should not outpace the growth of the system minimum load demand. Also, the size of future units are also equally important as to avoid frequent resource additions or system interruptions. The implementation of both supply-side and demand-side technologies in the future will also determine the distribution of units throughout the coming years.

As electricity demand will increase, there will be a pressing need for a new generating station to be built. Presently, both Kahului and Maalaea Generating Stations have limited space for additional generating units. Land has been appropriated to create a new generating site along Pulehu and Waiko Roads in Central Maui. After a steam turbine generator is installed at Maalaea Generating Station in 2007, all subsequent units will be installed at the new Waena Generating Station. This particular land is limited to producing 66 MW of electrical output of fossil fuel burning energy production. The remaining land will be used for alternative energy and ancillary facilities.

Currently, there are 68 operating substations in the system. In addition to these substations, there are four substations in the planning stages. Areas in which the transmission lines do not currently reach include the area from Waiehu around the northern West Maui Mountains to Napili and from Hana around the eastern base of Haleakala to Wailea.

The transmission system provides a link between the customers and source of generation. The transmission system is most efficient and effective when the entire system is intact. If a transmission line or a generating unit trips off-line, system frequency will increase, will not be able to stabilize, and may result in a complete shutdown of all generating units and transmission lines. The use of combustion turbine units helps to minimize the risk of a transmission system collapse. Since combustion turbines can quickly pick up load, it helps the system frequency to remain stable. Reducing line loading and the effective resistance of the transmission system can also lower system losses. The addition of new transmission lines and distributed generation can both accomplish this reduction of line loading and resistance.

D. Supply-Side and Demand-Side Management

The IRP process consists of balancing Demand-Side technologies with Supply-Side technologies. Supply-Side Management manages the increase of energy supplies, whereas Demand-Side Management modifies energy use to maximize energy efficiency. Supply-Side technologies range from conventional fossil-fuel resource options to renewable resource options. The majority of Maui's electricity is provided through fossil-fuel technologies. Maui, as well as the rest of the state of Hawaii, is severely dependent on imported petroleum. Almost 90 percent of Hawaii's energy needs are met by petroleum, and the use of DSM to alleviate this dependence is being actively pursued.

As Maui's energy demands increase, there will be a need for more generating units and Supply-Side Management. In terms of renewable energy sources, Maui has the lowest percentage of sales from renewable energy sources at 3.3 percent. In comparison, HECO has 4.7 percent of its sales attributed to renewable energy while HELCO has 28 percent. However, with the advent of a 20 MW wind farm, this percentage should increase accordingly.

Hawaiian Electric has already launched several initiatives in Demand-Side Management. Those initiatives include a commercial lighting DSM pilot program, solar water heating, implementing efficiency retrofits in Maui's public schools, and studying the feasibility of an ice storage unit for the Heat, Ventilation, and Air-Conditioning (HVAC) system at Maui Community College in which the units create ice during off-peak hours to be used as air conditioning during peak hours.

E. Projected Electrical Demand

The 1992 electrical system projections for the Maui Infrastructure Assessment determined that MECO would need a total of 266 MW of installed capacity by the year 2010. According to the results from the modeling, it was suggested that MECO, in the span of 18 years, would have to expand its generating capacity by 100 MW. MECO currently has 250.1 MW of installed generating capabilities and will increase that capacity to just over 300 MW by the year 2010. If this plan is completely followed, the actual generating capacity needed will eclipse the 1992 prediction by over 30 MW.

Based on linear and nonlinear projections, the recommended additions to generating capacity differ. If the population of Maui increases linearly for the next 20 years, a minimum of 65 MW should supplement the current generating capacity by 2020. However, as much as 130 MW might be needed if the yearly rate of electrical demand increases exponentially. As further projections of population and electrical demand are established, they should be closely compared to the values posted in this report, and it can be determined if electrical demand follows a linear or exponential path.

F. Communication Systems

Within the County of Maui, both telephone and cellular communication service are provided by Verizon Hawaii, while other private companies such as AT&T Wireless, Nextel, Sprint, and T-Mobile provide cellular telephone service.

The existing telephone system on Maui consists of a network of telecommunication links made by wire, fiber-optic lines, and microwave transmissions. Radio stations provide microwave links off of the island, including a link that connects Hana with the rest of Maui via Huehue on the island of Hawaii and Haleakala. The telephone system services three distinct clientele -- the domestic or household sector, the commercial or business client, and the wireless user that includes both businesses and residential consumers seeking mobility and wide area of coverage. Due to the heightened security and highly competitive nature of this industry, available data for all the three segments are limited.

Due to the rapid rate of technological change and an increasing customer base, equipment in the system varies widely in age and capability. Nevertheless, strict industry performance standards have minimized component and system incompatibility.

The residential and commercial telephone system on Maui currently has no apparent major limitations that severely impact voice service or quality.

G. Cable Systems

Oceanic – Time Warner Cable, a division of AOL-Time Warner, provides cable television service for the County of Maui. The company has built, maintained and operated cable systems for over 20 years.

A study performed by Oceanic–Time Warner Cable in 1996 accounted for 56,503 residential and commercial addresses, where cable service was available. The present customer count is at 62,757. This places the growth rate of potential cable customers at approximately 11%, over the last six years.

In 2001, Oceanic–Time Warner Cable completed an upgrade of the existing cable system on Maui. The basic premise of the design is to divide customers into 500 home “pockets” or serving areas (SA’s). Each SA has on optic to RF converter (node). These nodes are then fed via optical fiber from a hub. Each hub is capable of serving 40 SA’s or 20,000 customers. Hubs are expandable simply by the installation of additional equipment. Signals are passed between hubs via an optical “super trunk”.

There are currently 4 hubs operating on Maui. The hub areas include Lahaina, Wailuku, Pukalani, and Kihei and mirror the customer distribution listed above. Hana is currently fed via microwave link between Hana and Puu Nianiau (on Haleakala). Similarly, both Lanai and Molokai are served via a microwave link originating in Lahaina.

The current hubs can accommodate an additional 17,000 new subscribers. Distribution fiber cables have been placed in anticipation of serving new housing projects. Hub expansion occur simply by adding additional equipment. Additional hubs or mini-hubs may be “dropped” along the fiber trunk should this need arise. The current capacity is projected to support similar, historic growth beyond the next decade.

Should growth exceed expectations, the present infrastructure has the flexibility to accommodate additional subscribers without major additions. Oceanic – Time Warner Cable is committed to provide state-of-the-art cable service to the residents of Maui for the duration of their cable franchise. The current system platform in place is geared toward that commitment.

I. INTRODUCTION – ELECTRICAL

This section presents an assessment of the existing electrical power generation, and transmission systems as well as future plans and requirements for meeting the electrical demands of the island through 2020.

Inasmuch as electrical power is supplied by Maui Electric Company (MECO), which is a private entity regulated by the Public Utilities Commission (PUC), future planning of electrical facilities is not a County function. Thus, this report is intended to provide an overview of major planning issues concerning electrical power on the island as opposed to specifying needed improvements.

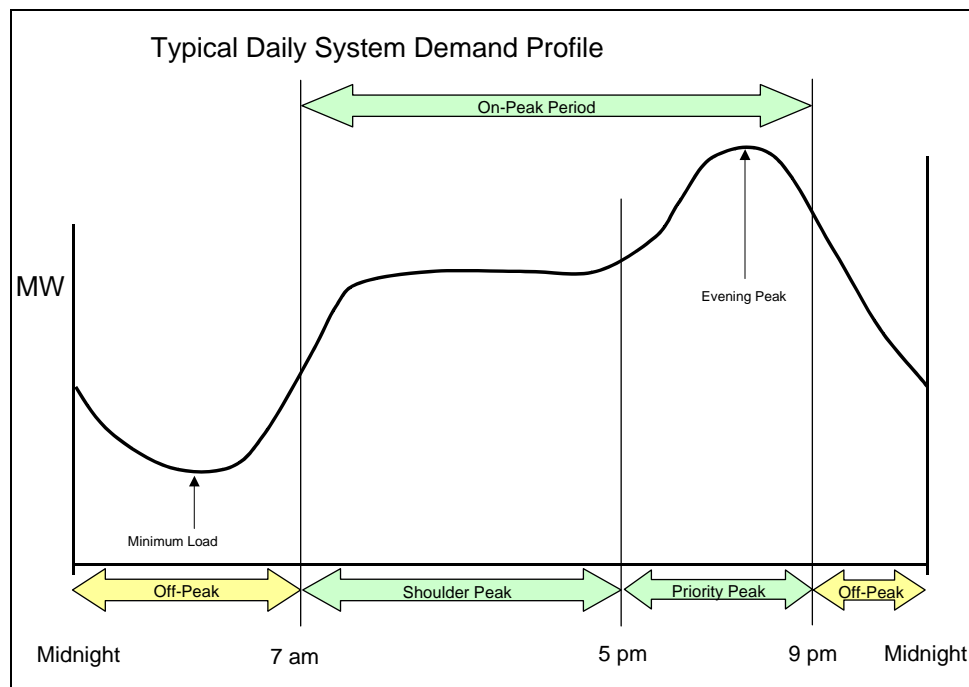
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II. DEMAND AND GENERATION

Demand for electricity in this study is divided into two periods: on-peak demand and off-peak demand. The grouping of on-peak demand is further categorized into shoulder peak demand and priority peak demand. It is due to the daily cyclical pattern of electric power consumption that demand is evaluated in this manner. This cyclical pattern permits the electric power company to utilize its generating capacity in the lowest cost manner given all levels of demand. The following subsections review each load type by examining the magnitude of power demanded and the consumers using this electricity. A graphical representation of MECO's electrical demand is represented in Figure 1.

Figure 1

Typical Daily System Demand Profile



A. Off-Peak Demand and Generation

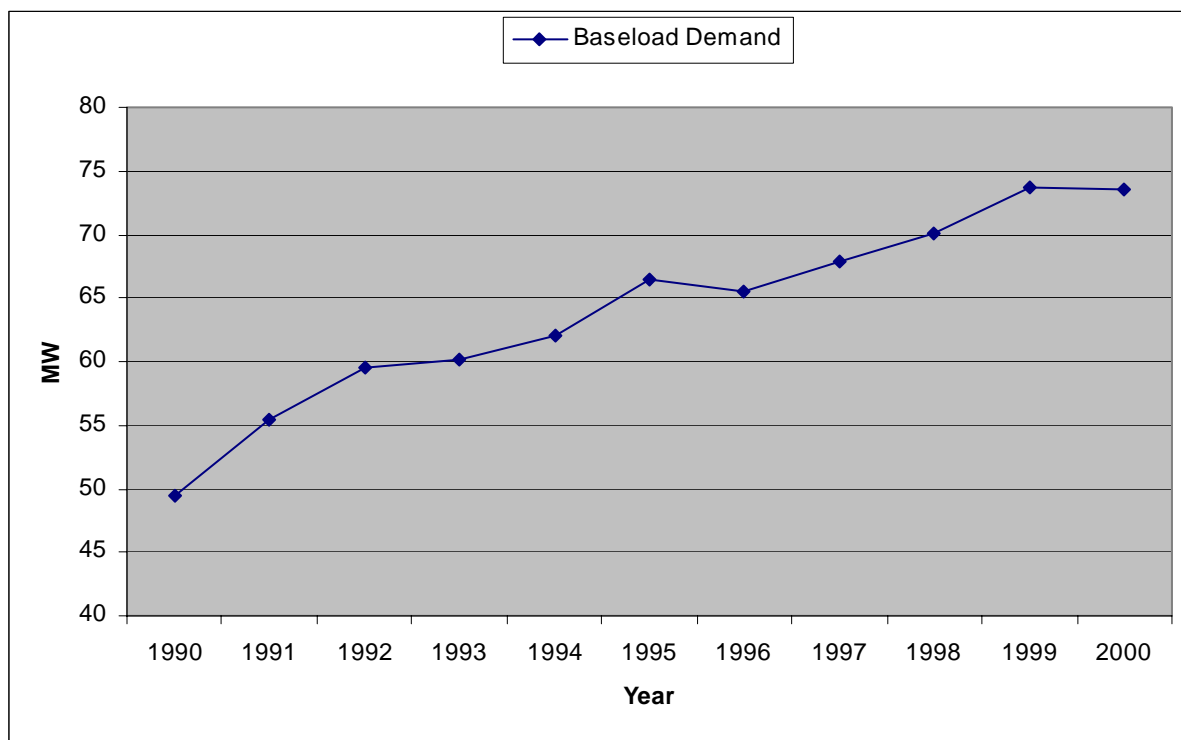
The off-peak demand or baseload demand is defined as the smallest load that is placed upon the system. This baseload demand is the minimum electricity demanded by commercial, industrial, and domestic users, in addition to infrastructure such as street lighting and wastewater reclamation. The generating stations must always provide the electricity required for this level of generation. Off-peak demand is typically experienced from the hours of 9:00 pm until roughly 7:00 am. This period of off-peak demand includes the system minimum load demand which is the smallest load demand placed on the electrical system. This system minimum load demand is typically 40% of the annual Evening Peak demand and usually occurs between the hours of 3:00 and 4:00 am daily.

The electricity that is generated to meet baseload demand is generally provided by the largest, most durable, and cost efficient generating equipment employed by the system. Baseload units are typically more difficult to schedule for maintenance because they must be available during seasons with the highest peak demand and are not designed for frequent start-ups and shutdowns. The Kahului Generating Station provides baseload generation through two large fuel oil-fired steam generators. The Maalaea Generating Station meets baseload demand through one dual-train combined cycle unit and one large Mitsubishi diesel engine generator unit. The dual-train combined cycle is comprised of two combustion turbine units and one steam turbine generator. Efficiency of this type of combination of engine configuration will be studied in subsequent sections. MECO is also currently obligated to purchase 8 Megawatts (MW) of baseload generation from Hawaiian Commercial and Sugar Company (HC&S) during the baseload demand timeframe.

According to the 1992 Infrastructure Assessment, Maui County experienced an annual growth in baseload demand of approximately 2 MW per year at a growth rate of 8.6 percent. This 1992 testing period from 1979-1990 yielded a total increase in baseload demand of 25 MW. More recently, the baseload demand on Maui increased by over 24 MW during the years 1990-2000 for an average minimum demand growth rate of 4.1 percent. By these figures, it can be determined that historically baseload demand has followed a fairly linear pattern, and it will possibly follow a similar pattern in the future (See Chart 1).

Chart 1

Maui Baseload Demand



B. On-Peak Demand and Generation

The on-peak period starts when businesses and residences first begin their daily activities, culminates at the evening peak demand and sharply drops off to off-peak levels as activities are reduced. This on-peak period occurs during the hours of 7:00 am through 9:00 pm and includes the greatest demand placed upon the electrical system. The evening peak demand occurs during the early evening time when additional electrical demands are placed on the electrical system from hotels, resorts, and residential users returning to their homes. As previously mentioned, the on-peak demand period is divided into two distinct periods known as the shoulder peak demand period and the priority peak demand period. The shoulder peak demand period starts at 7:00 am and merges into the priority peak demand at approximately 5:00 pm, which lasts until approximately 9:00 pm.

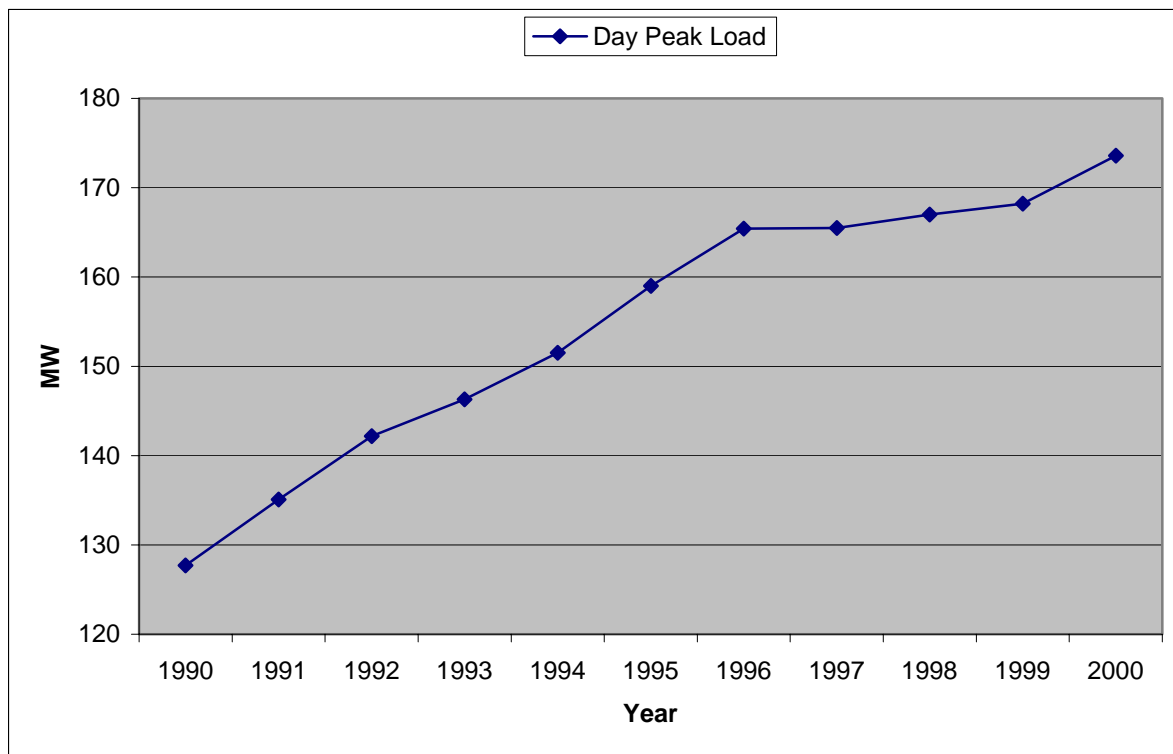
1. Shoulder Peak Demand

To meet the shoulder peak demand, generation from baseload units is increased to optimum operating levels and additional cycling capacity is connected to the electrical grid. Characteristics of this cycling type of generating capacity are those units that are easily started and shut down. Cycling generating units typically have a higher operating cost than the baseload units as well as lower initial facility cost. Unlike baseload units, cycling units are equipped to withstand both the thermal and mechanical stresses of daily unit start-ups and shutdowns in addition to continuous changes in output power requirements.

The shoulder peak demand on Maui is met by three large-sized cycling Mitsubishi diesel engine generator units and six medium-sized cycling diesel engine generators at the Maalaea Generating Station, and two oil-fired cycling steam units at the Kahului Generating Station.

During the 1990 through 2000 period, MECO's shoulder peak demand increased by over 43 MW or nearly 36 percent as shown in Chart 2. The average shoulder peak demand growth rate over this same period was 3.1 percent yearly.

Chart 2

Maui Shoulder Peak Demand**2. Priority Peak Demand**

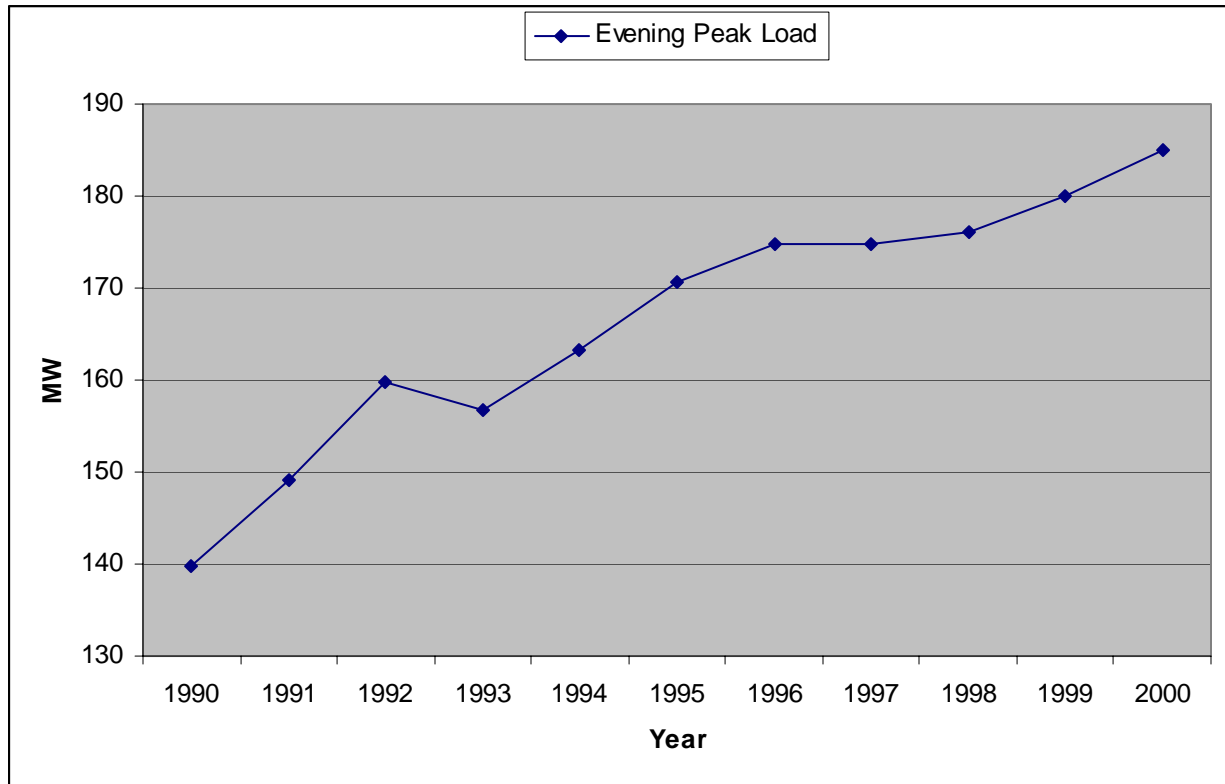
The priority peak demand period experiences the largest daily demand on the electrical system. The highest value during this period is referred to as the evening peak demand and occurs primarily during the 6:00 pm – 7:00 pm timeframe, depending on the seasonal month. On Maui, the annual peak generally takes place somewhere between the October through December time period.

To meet the priority peak demand, generation is typically provided by the smaller, relatively less efficient generating units that can be quickly started and connected to the electrical grid.

The evening peak demand on Maui is provided by several of the same cycling units used in meeting the shoulder peak demand along with five additional small-sized peaking diesel engine generating units located at the Maalaea Generating Station.

During the 1990-2000 period, MECO's evening peak demand increased by over 45 MW at an average annual rate of 3.0 percent. This evening peak demand has increased by 32 percent since 1990 (See Chart 3).

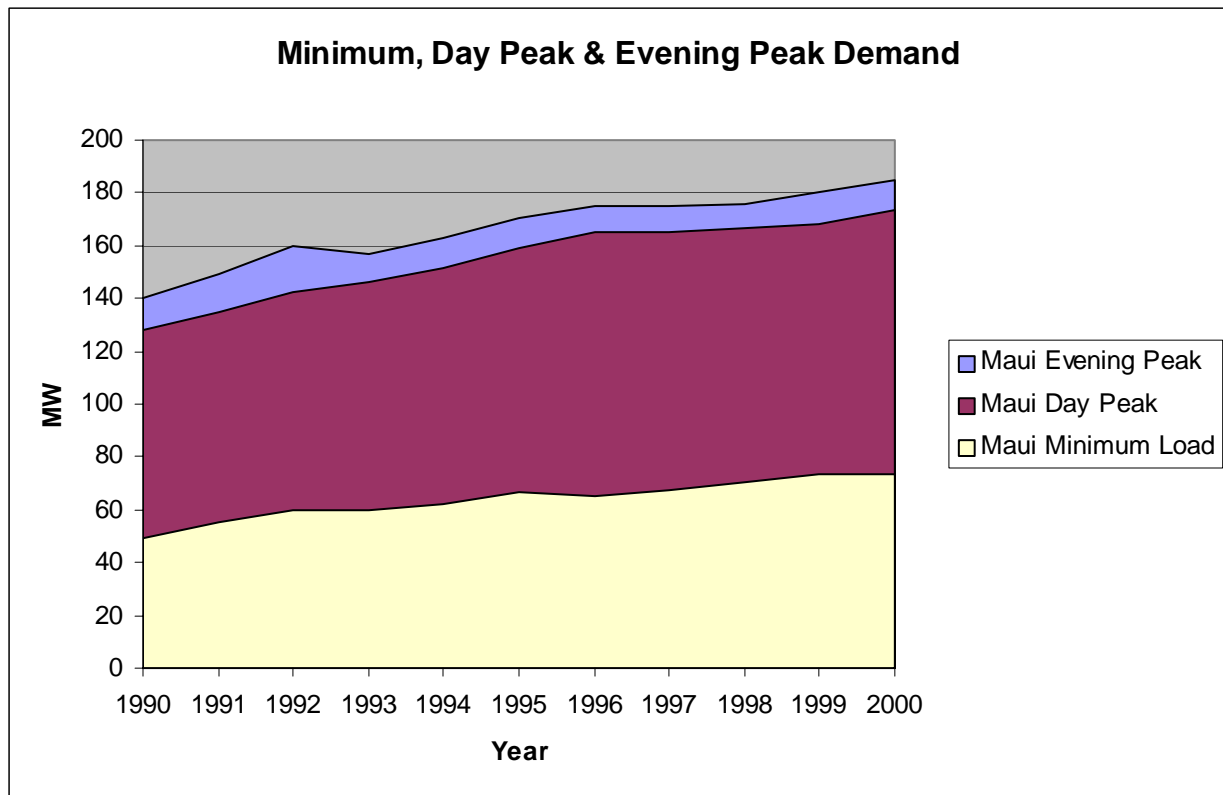
Chart 3
Maui Priority Peak Demand



C. Demand Growth

The following graph (Chart 4) represents the configuration of demand on Maui. The graph reveals that during the latter half of the decade, the percentage increase for electrical demand slightly declined. The yearly evening peak demand growth rate for the years 1995-2000 was approximately 1.7 percent. In comparison, the average growth rate was 2.9 percent throughout that particular decade. Although the recent amount of electrical demand suggests that the electrical demand is decreasing, it is unlikely that such a trend will be sustainable indefinitely.

Chart 4

Minimum, Day Peak & Evening Peak Demand**D. Demand Differential**

The differential between the minimum load demand and the day peak load demand was calculated. The results are shown in the following table (Table 1). The average differential was approximately 91 MW. Since 1990, there has been an increase in the difference between minimum load demand and day peak demand from 78.2 MW to 100 MW. Recent trends had shown a reduction in annual increase of differential, but the results from 2000 continued the upward increase between baseload demand and day peak demand.

Table 1**Differential Between Minimum Demand and Day Peak Demand**

Day Peak Load	Minimum Load	Differential
127.7	49.5	78.2
135.1	55.4	79.7
142.2	59.5	82.7
146.3	60.1	86.2
151.5	62	89.5
159	66.4	92.6
165.4	65.5	99.9
165.5	67.8	97.7
167	70.1	96.9
168.2	73.2	95
173.6	73.6	100

All values are in Megawatts (MW)

The minimum load demand increased by 24.1 MW during the 1990-2000 period. In comparison, the day peak load nearly doubled that amount. In that same ten-year span, the day peak load expanded to 45.9 MW. With this difference in demand loads, it gives insight into what type of generating units should be installed in the future. If this trend continues, the units that should be installed should be capable of both baseload and cycling generation. Proportionally, there was a greater amount of cycling generation that needed to be installed during the years 1990-2000. Based on continuing trends, day peak load and evening peak load will be over two times as great as the baseload demand. Given these circumstances, the installed capacity should be broken down into the following categories. In 2020, the expected increase in baseload demand is 40.6 MW. Day peak load will increase by 82.3 MW. Based on these figures, there should be a minimum of 41 MW installed of baseload generation. To meet the day peak load and to compensate for an unexpected increase in baseload generation, a minimum of 83 MW of cycling units should be installed. These cycling units should have a certain percentage that can convert their cycling generation into baseload generation given fluctuations in electricity demand. Lastly, a minimum of 60 MW of peaking units will have to be installed to meet the future evening peak demands.

III. EXISTING FACILITIES

A. Generating Facilities

The installed generating capacity that are currently owned and operated by MECO on the island of Maui is 212.90 MW. This capacity is divided between the Maalaea Generating Station that has a reserve capability of 175.30 MW and the Kahului Generating Station that has a reserve capability of 37.60 MW. Tables 2 and 3 provide both the normal capability and reserve capability for all units in addition to the year each unit was commissioned. The difference between normal capability and reserve capability is the maximum operating level that can be obtained from these plants.

The total generating capacity from these stations are supplied by 26 generating units at two power plant sites and one substation site on Maui. The four steam units at the Kahului Generating Station use No. 6 fuel oil with the capability of burning No. 2 diesel fuel oil. Fifteen diesel engine generators fueled with diesel fuel oil are located at the Maalaea Generating Station. MECO's first dual-train combined cycle (DTCC No. 1) unit, located at the Maalaea Generating Station, was placed in commercial operation in 1993. It consists of two combustion turbine (CTs) and one unfired steam turbine generator (STG). MECO's second dual-train combined cycle (DTCC No. 2) unit, also located at Maalaea, is currently being added to the system using a phased installation approach. The first CT (Phase I) was placed in commercial operation in December 1998. The second CT (Phase II) was placed in commercial operation in September 2000, and the STG (Phase III) is projected for completion in 2007. In addition, two standby diesel engine generators fueled with diesel fuel oil were installed in April 2001 at Hana Substation No. 41 to provide electric power to the Hana Community primarily during planned maintenance or unplanned power outages of the transmission line to Hana.

Additional power from Hawaiian Commercial and Sugar (HC&S) supplements the total installed generating capacity of MECO. MECO has under contract the purchase of an additional 12 MW from HC&S during the on-peak period and 8 MW during the off-peak period. HC&S has also agreed to provide an additional 4 MW of generation capacity for system protection. Both this system protection and the additional generation capacity are under contract until December 31, 2007. Including the power bought from HC&S, the total generating capacity equals 228.90 MW.

The power that is generated by HC&S comes from the Puunene Mill located in Puunene. The Puunene Mill plant uses bagasse (sugar cane waste), diesel mixed with bagasse, and coal to generate electricity. The plant produces 44 MW from three traveling grate boilers consisting of two 12 MW generators and one 20 MW generator.

As mentioned previously in the section highlighting generation growth, MECO is also in the process of installing new generators. If unit M-19, a combustion turbine unit that is currently used for peak demand, is included in the total generating capacity, the total generating capacity for MECO will be 250.1 MW.

Table 2**2001 Kahului Plant Installed Generation Capacity**

Unit	Type	Normal Capability (MW)	Reserve Capability (MW)	Service Date	2001 Test Year Age
1	Steam	5.00	5.90	1948	53
2	Steam	5.00	6.00	1949	52
3	Steam	11.50	12.70	1954	47
4	Steam	12.50	13.00	1966	35
Total		34.00	37.60		

Source: Maui Electric Company, Limited, Generating Capabilities

Table 3**2001 Maalaea Plant Installed Generation Capacity**

Unit	Type	Normal Capability (MW)	Reserve Capability (MW)	Service Date	2001 Test Year Age
X-1	Diesel	2.50	2.50	1987	14
X-2	Diesel	2.50	2.50	1987	14
1	Diesel	2.50	2.50	1971	30
2	Diesel	2.50	2.50	1972	29
3	Diesel	2.50	2.50	1972	29
4	Diesel	5.60	5.60	1973	28
5	Diesel	5.60	5.60	1973	28
6	Diesel	5.60	5.60	1975	26
7	Diesel	5.60	5.60	1975	26
8	Diesel	5.60	5.60	1977	24
9	Diesel	5.60	5.60	1978	23
10	Diesel	12.50	12.50	1979	22
11	Diesel	12.50	12.50	1980	21
12	Diesel	12.50	12.50	1988	13
13	Diesel	12.50	12.50	1989	12
14	CT	20.00	20.00	1992	9
15	Steam	18.00	18.00	1993	8
16	CT	20.00	20.00	1993	8
17	CT	21.20	21.20	1998	3
Total		175.30	175.30		

Source: Maui Electric Company, Limited, Generating Capabilities

B. Generating Facilities Growth

To meet the past demand growth on the island of Maui in the 1990-2000 period, MECO installed a total of 100 MW of additional generating capacity. In 1992, Maalaea Unit 14 (M14), a 20 MW combustion turbine, was installed at the Maalaea Generating Station followed in 1993 by Maalaea Units 16 (M16) and 15 (M15), a 20 MW combustion turbine and an 18 MW steam turbine generator, respectively. Maalaea Units 14, 16, and 15 comprise the Maalaea Dual Train Combined Cycle No. 1 in which the exhaust heat produced by the two combustion turbines (M14 and M16) is used to power the steam turbine generator (M15) in the efficient combined cycle operation. In 1998, Maalaea Unit 17 (M17), a 21 MW combustion turbine was installed at the Maalaea Generating Station. In 2000, Maalaea Unit 19 (M19), a 21 MW combustion turbine, was also installed in the Maalaea Generating Station. These two combustion turbine units are targeted to be converted to combined cycle operation in 2007 after the installation of the steam turbine generator, Maalaea Unit 18 (M18). Units M17 and M19 are currently being used as peaking units until M18 is installed.

Future units to these generating stations must have several considerations taken into account. Increases in baseload, day peak, and evening peak demands will determine which type of units would be installed in the future. For example, if the sum of the minimum capabilities of baseload units during the minimum load demand period exceeds the actual minimum demand, there would be an excess of electricity. The baseload units in excess would have to be cycled which would increase thermal and mechanical stress on the unit. This, in turn, would cause an increase in operation and maintenance costs and possibly forced outages. Thus, future baseload unit additions should not outpace the growth of the system minimum load demand.

The size of future units are also equally important. If future installations of generating units are too small, frequent resource additions would be required and would also increase the need for financial and manpower resources. Conversely, if the units were too large, the unexpected loss of a large unit could most likely cause a system interruption, because of load shedding. The implementation of both supply-side and demand-side technologies in the future will also determine the distribution of units throughout the coming years.

As electricity demand will increase, there will be a pressing need for a new generating station to be built. Presently, both Kahului and Maalaea Generating Stations have limited space for additional generating units. Land has been appropriated to create a new generating site along Pulehu and Waiko Roads in Central Maui. After a steam turbine generator is installed at Maalaea Generating Station in 2007, all subsequent units will be installed at the new Waena Generating Station. This particular land is limited to producing 66 MW of electrical output of fossil fuel burning energy production. The remaining land will be used for alternative energy and ancillary facilities.

C. Existing MECO Transmission Grid

The current transmission grid on Maui consists primarily of seven 69 Kilovolt (KV) lines originating at the Maalaea power plant and four 23 KV lines originating at the Kahului power plant. Three of the 69 KV lines leaving the Maalaea plant service the West Maui/Lahaina area. Two other 69 KV lines service the Wailuku/Kahului area. The sixth 69 KV line services Kihei/Wailea, continues up-country to Kula over to Pukalani, and then down to Kahului. At the Kula substation, a 23 KV line breaks off of the sixth 69 KV line to service Haleakala customers. The remaining 69 KV line leaving the Maalaea plant services Kula and intersects the sixth 69 KV line.

The four 23 KV lines originating at the Kahului plant service the Wailuku/Kahului area, Haiku/Makawao area, and also service East Maui. In Kahului, the 23 KV and 69 KV lines link at the Kanaha substation while in Wailuku these lines join at the Walinu substation. In Pukalani, the Kihei/Wailea/Kula 69 KV line links with the 23 KV Haiku/Makawao line at the Pukalani substation. From Pukalani, the 23 KV line extends to Makawao and then down to Haiku. An extension of one 23 KV line runs from Kahului around the base of Haleakala through Paia and terminates in Hana.

Currently, there are 68 operating substations in the system. In addition to these substations, there are four substations in the planning stages. Areas in which the transmission lines do not currently reach include the area from Waiehu around the northern West Maui Mountains to Napili and from Hana around the eastern base of Haleakala to Wailea.

D. Transmission Grid Growth

The transmission system provides a link between the customers and source of generation. The transmission system is most efficient and effective when the entire system is intact. If a transmission line or a generating unit trips off-line, system frequency will increase, will not be able to stabilize, and may result in a complete shutdown of all generating units and transmission lines. The use of combustion turbine units helps to minimize the risk of a transmission system collapse. Since combustion turbines can quickly pick up load, it helps the system frequency to remain stable. Reducing line loading and the effective resistance of the transmission system can also lower system losses. The addition of new transmission lines and distributed generation can both accomplish this reduction of line loading and resistance.

Generators are used to maintain system voltage by regulating the supply of reactive power (VARs). These generating units must be capable of supplying VARs required by both the customer and the transmission system in order to maintain the required voltage levels to the customers. If the demand for VARs outweighs the supply of VARs, additional generating units can be added to contribute to the VAR supply or additional transmission lines can be added to the transmission system. With the additional transmission lines, it would reduce the average load on each line, and the system would have less VAR losses and a better voltage profile.

IV. SUPPLY –SIDE AND DEMAND-SIDE MANAGEMENT

The IRP process consists of balancing Demand-Side technologies with Supply-Side technologies. Supply-Side Management manages the increase of energy supplies, whereas Demand-Side Management modifies energy use to maximize energy efficiency. Supply-Side technologies range from conventional fossil-fuel resource options to renewable resource options. The majority of Maui's electricity is provided through fossil-fuel technologies such as simple cycle combustion turbines, single and dual-train combined cycle units and diesel engine generator resources. Maui, as well as the rest of the state of Hawaii, is severely dependent on imported petroleum. Almost 90 percent of Hawaii's energy needs are met by petroleum, and the use of DSM to alleviate this dependence is being actively pursued.

A. Supply-Side Management

As Maui's energy demands increase, there will be a need for more generating units. These generating units will typically be combustion turbine units and steam turbine units, so that they can be combined to create more efficient combined-cycle units. In addition, two stand-by generators were installed to improve reliability in the Hana area. Lastly, new generation units that will use fossil-fuel technologies will be deferred to see if developing renewable and alternate energy sources can be used instead. In terms of renewable energy sources, Maui has the lowest percentage of sales from renewable energy sources at 3.3 percent. In comparison, HECO has 4.7 percent of its sales attributed to renewable energy while HELCO has 28 percent. However, with the advent of a 20 MW wind farm, this percentage should increase accordingly.

B. Demand-Side Management

Hawaiian Electric has already launched several initiatives in Demand-Side Management. Maui Electric Company, in conjunction with other affiliates of Hawaiian Electric, have already implemented a 2.5 million dollar commercial lighting DSM pilot program. Since 1996, solar water heating has led to almost 2070 kilowatts in energy savings. This amount of electricity is equal to 15,600 barrels of oil each year.

There has also been an audit of the energy consumed in lighting of Maui's public schools. This study, done by Maui Community College, produced a financial analysis for implementing efficiency retrofits. If Maui's public schools were to replace T12 fluorescent lamps with T8 lamps and electronic ballasts, it would result in a 34 percent reduction in lighting energy consumption. The 32 schools in the study would save an estimated 369,000 dollars per year. In addition to this energy study, several of the public schools were outfitted with photovoltaic solar technology. The five systems contribute to a peak rating of 2.3 kilowatts.

Maui Community College has also begun a study on the efficiency of its energy management system as well as its Heat, Ventilation, and Air-conditioning (HVAC) system. The feasibility of

an ice storage unit for this HVAC system is of primary interest. Ice storage units can be a very practical method of demand-side management. These units create ice during off-peak hours when demand is not high. During the daytime, the ice is then used as air conditioning.

V. PROJECTED ELECTRICAL DEMAND

A. Historical Projections

The 1992 electrical system projections for the Maui Infrastructure Assessment were determined using least squares regression modeling. According to the results from this certain type of modeling, it was determined that MECO would need a total of 266 MW of installed capacity by the year 2010. According to the results from the modeling, it was suggested that MECO, in the span of 18 years, would have to expand its generating capacity by 100 MW. As previously touched upon in Section 5, MECO currently has 250.1 MW of installed generating capabilities and will increase that capacity to just over 300 MW by the year 2010. If this plan is completely followed, the actual generating capacity needed will eclipse the 1992 prediction by over 30 MW.

The use of least squares regression is still helpful in determining future values for electrical power demand. As noted in the previous assessment in 1992, periodic confirmation of the validity of the relationships between dependent and independent variables must be assessed to ensure the legitimacy of the current relationship equation. Thus, the projected values shown should be reassessed whenever revised tourist counts and resident populations are available.

B. Linear Projections

The projected values for power demand were generated using least squares regression modeling. The goal of regression analysis is to determine the values of parameters for a function that will cause the function to best fit a set of provided data points. Regression can either be plotted linearly or exponentially depending on the values of the independent variables. Using resident population and tourist count as the independent variables, an equation was determined that predicted the future values for power demand for the next 15 years. As determined from Section 2 of this report, commercial, industrial and domestic users influence a good portion of power demand. Thus, as both residential population and defacto population increased, power demand would increase in a similar fashion. This particular function was determined using data spanning from the years 1990-2000.

In least squares regression modeling, it is nearly impossible to determine an exact fit between the function and the actual data. There is usually a difference between the actual value of the dependent variable and its predicted value for a particular data observation point. This error between the actual and predicted value is known as the deviation or residual. The deviations from each observation point is summed and squared. Least squares regression seeks to minimize the sum of the squared deviation values for a given set of observations. In least squares regression, there is also a correlation coefficient, R-squared, that determines the “goodness” of a regression equation. Typically, the closer R-squared is to 1, the better the fit of the equation. As a general rule of thumb, an R-squared that is in excess of 0.90 typically signifies a strong fit of the data by the equations.

Using resident population and average daily visitor census for the County of Maui for the years 1990-2000, projected power demand equations were determined. All three of the equations resulted in R-squared greater than 0.90, and thus, there is a good-fitting linear relationship between the population of Maui and power demand. Future values of resident population and average visitor census were taken from the State Department of Business, Economic Development and Tourism (DBEDT) and used to determine future electrical demand. The following table contains the projected values for load demand based on these variables.

Table 4

Projected Maui Electric Power Demand

	Year	Minimum Load	Day Peak Load	Evening Peak Load
Low	2005	81.8	191.1	198.9
	2010	90.5	208.8	214.7
	2015	99.2	226.5	230.5
	2020	107.8	244.1	246.3
Base	2005	83.1	193.5	201.6
	2010	93.2	213.9	220.6
	2015	103.7	234.9	240.2
	2020	114.2	255.9	259.9
High	2005	84.4	195.9	204.3
	2010	96.2	219.4	226.9
	2015	108.6	244.1	250.7
	2020	121.5	269.5	275.5

Loads are in Megawatts (MW)

As noted, there are three divisions for projected electric power demand. These divisions are based on low, base, or high growth rates of both resident population and average tourist count. Table 4 shows that the use of the highest possible resident population growth and average tourist count will result in a maximum electric load of 275.5 MW. MECO, in order to operate the utility in a least cost, safe and reliable manner, should install generation capacity that exceeds the demand by no less than 20 percent. Using this approach and assuming that the peak electrical demand will be 275.5 MW, MECO should install at least 85 MW by the year 2020. If the base evening peak load were used, MECO would need to install a minimum of 65 MW by 2020. Based on the planned additions for generating capacity to MECO's generation facilities, this predicted energy demand will easily be met. However, MECO plans for 361.2 MW of generating capacity, much above the needed amount. The following section will go over the reasoning for such an increase in generating capacity.

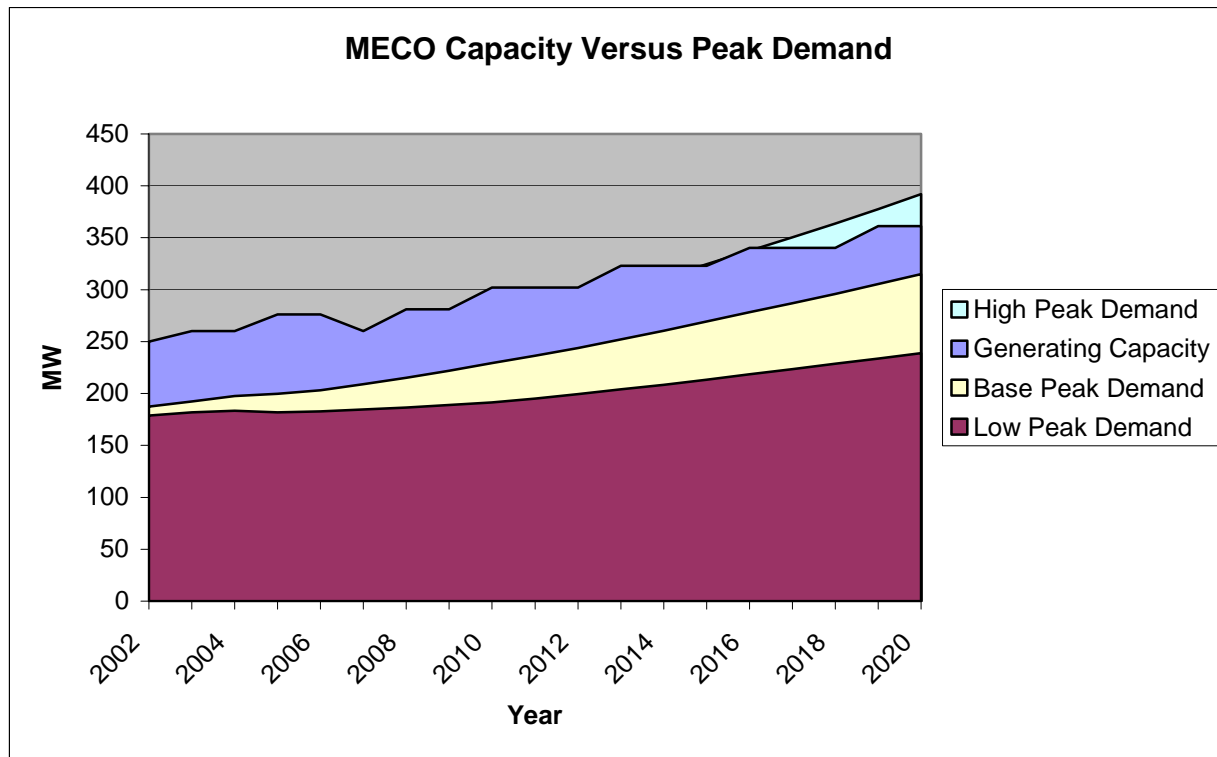
C. Nonlinear Projections

In the previous section, the data for the years 1990-2000 in electrical demand followed a linear path. However, it is also possible that the demand would follow an exponential curve. This curve would be unnoticeable for a span of ten years, but it would be noticeable if decades of energy demand were plotted. In addition, an expected growth spurt in population and businesses in the future could also contribute to the increase in demand. Based on predictions from MECO, energy demand was determined until the year 2020. These predictions follow a low sloping exponential curve. As mentioned in the previous section, the addition of a 10 MW wind farm, four diesel fired combustion turbines and one steam turbine will create an increase of generating capacity to 361.2 MW by the year 2020. Chart 5 shows this increase in capacity against the projected Low, Base and High Peak demands.

For the utility to operate in a least cost, safe, and reliable manner, the installed generation should exceed the demand by no less than 20 percent. If we take this rule into account, the projected generating capacity will be adequate throughout the year 2020 only for the low peak demand. The projected generating capacity will keep pace with the base peak demand until the year 2016. Beyond 2016, the generating capacity will exceed the base peak demand by less than 20 percent. If high peak demand is considered, electrical demand will be greater than actual generating capacity by 2016, and additional generating capacity will have to be installed just to equal the increased demand. This high peak demand will also violate the 20 percent rule by the year 2007. Thus, if this high peak demand is taken into account, the generating capacity will only be adequate until the year 2007.

According to MECO's values for electric demand, the peak load for base demand would be 314.9 MW in the year 2020. If we take the "20-percent rule" into account, the minimum additional generating capacity in 2020 would be approximately 130 MW.

Chart 5

MECO Generating Capacity Versus Predicted Peak Demands**D. Future Actions**

Based on the predictions in the preceding sections, the recommended additions to generating capacity differ. If the population of Maui increases linearly for the next 20 years, a minimum of 65 MW should supplement the current generating capacity by 2020. However, as much as 130 MW might be needed if the yearly rate of electrical demand increases exponentially. As further projections of population and electrical demand are established, they should be closely compared to the values posted in this report, and it can be determined if electrical demand follows a linear or exponential path.

APPENDIX 1: POWER DEMAND**Table A-1****1990-2000 Power Demand**

Year	Evening Peak Demand	Day Peak Demand	Minimum Demand
1990	139.8	127.7	49.5
1991	149.1	135.1	55.4
1992	159.7	142.2	59.5
1993	156.7	146.3	60.1
1994	163.2	151.5	62
1995	170.7	159	66.4
1996	174.8	165.4	65.5
1997	174.7	165.5	67.8
1998	176	167	70.1
1999	180.1	168.2	73.7
2000	185.1	173.6	73.6

Values are in Megawatts (MW)

Source: Maui Electric Company, Electrical Demand

Table A-2**2002-2020 Power Demand**

Year	Low Case	Base Case	High Case
2002	178.7	187.4	203.6
2003	181.9	192.4	212.2
2004	183.4	197.7	219
2005	181.8	199.6	222.9
2006	182.9	203.2	229.8
2007	184.6	209	237.5
2008	186.4	215.1	245.8
2009	188.8	221.9	255
2010	191.4	229.2	264.7
2011	195.2	236.3	275.2
2012	199.3	243.9	286.6
2013	203.9	252.1	298.7
2014	208.5	260.5	311.4
2015	213.4	269.4	324.7
2016	218.6	278.2	337.5
2017	223.5	286.9	350.3
2018	228.6	296	363.7
2019	233.7	305.3	377.6
2020	239	314.9	392

All Values Are In Megawatts (MW)

APPENDIX 2: POPULATION PROJECTIONS

The following tables and charts are part of the process used to determine the figures in section 6 of this report. The previous assessment used tourist count and residential population to determine a relationship for electrical demand. Using the same independent variables, equations for projected electrical demand were created. The data for resident population and tourist count were taken from the State of Hawaii Data Book 2001 and are included below. The base or baseline projection is the State's best guess regarding visitor census and resident population. The values are based on trends over historical data and incorporate linkages within different sections of Maui's economy. The low and high projections are considered as a "zone of likelihood". Any changes in conditions affecting the population, large or small, would not likely cause a value outside of that "zone". The preferred projection used is the baseline projection as it provides a median for analysis.

Table A-3

Historical Average Visitor Census and Resident Population

Year	Average Daily Visitor Census	Resident Population
1990	37657	101709
1991	37060	105599
1992	41854	108585
1993	42132	111944
1994	42933	114754
1995	42751	117895
1996	42724	120689
1997	43383	122772
1998	42864	124648
1999	43992	126160
2000	43854	128241

Source: State of Hawaii Data Book 2001

Table A.-4**Average Visitor Census and Resident Population Projections**

Year	Low Visitor Census	Low Resident Population
2005	45340	138564
2010	47060	149144
2015	48845	159777
2020	50697	170264
Year	Base Visitor Census	Base Resident Population
2005	46865	139573
2010	50476	151269
2015	54363	163265
2020	58547	175136
Year	High Visitor Census	High Resident Population
2005	48431	140533
2010	54113	153522
2015	60457	167053
2020	67543	180757

Source: State of Hawaii Data Book 2001

APPENDIX 3: TRANSMISSION LINE DIAGRAM

Figure A-1

Maui Transmission Line Diagram

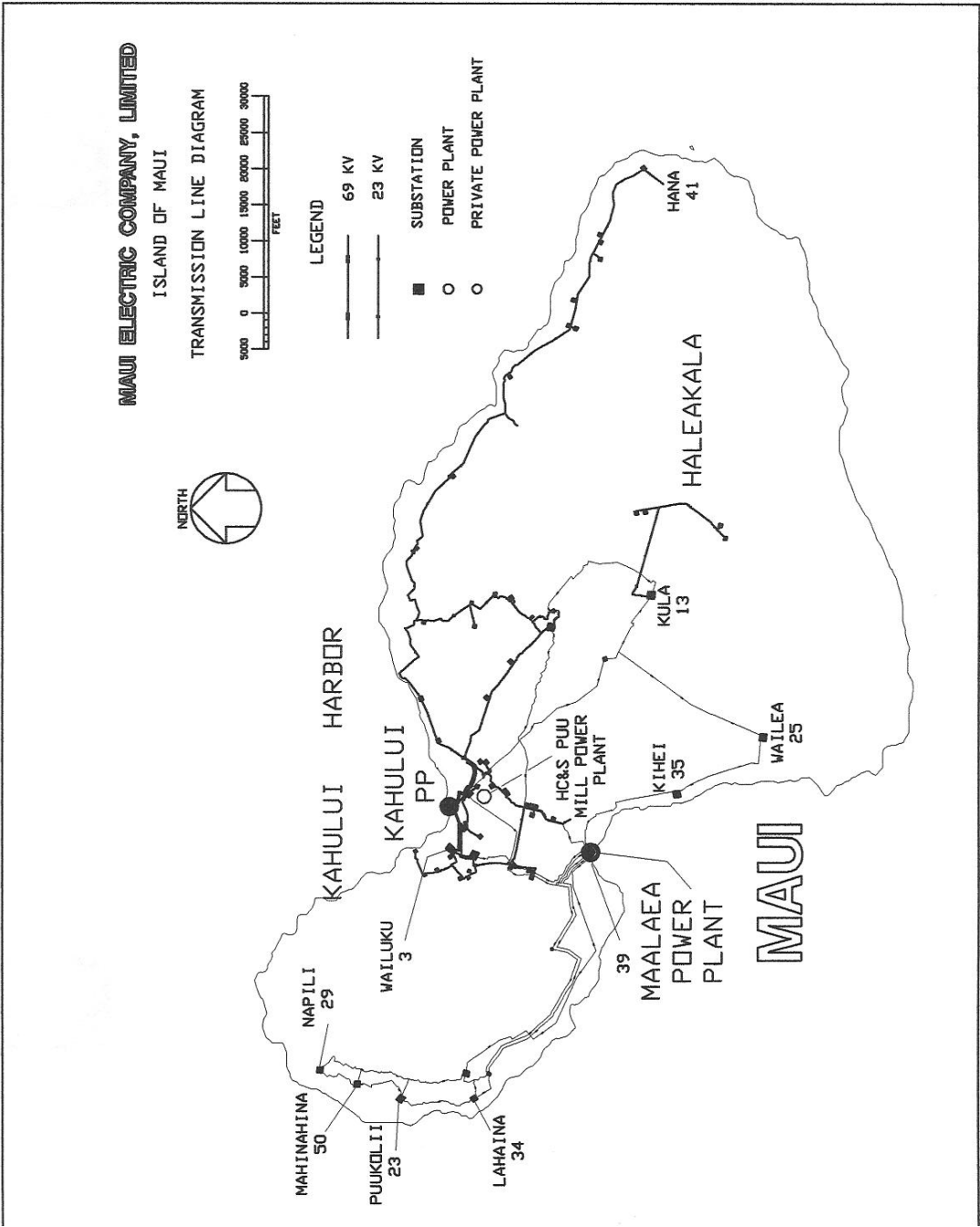


Figure A-2

Molokai Transmission Line Diagram

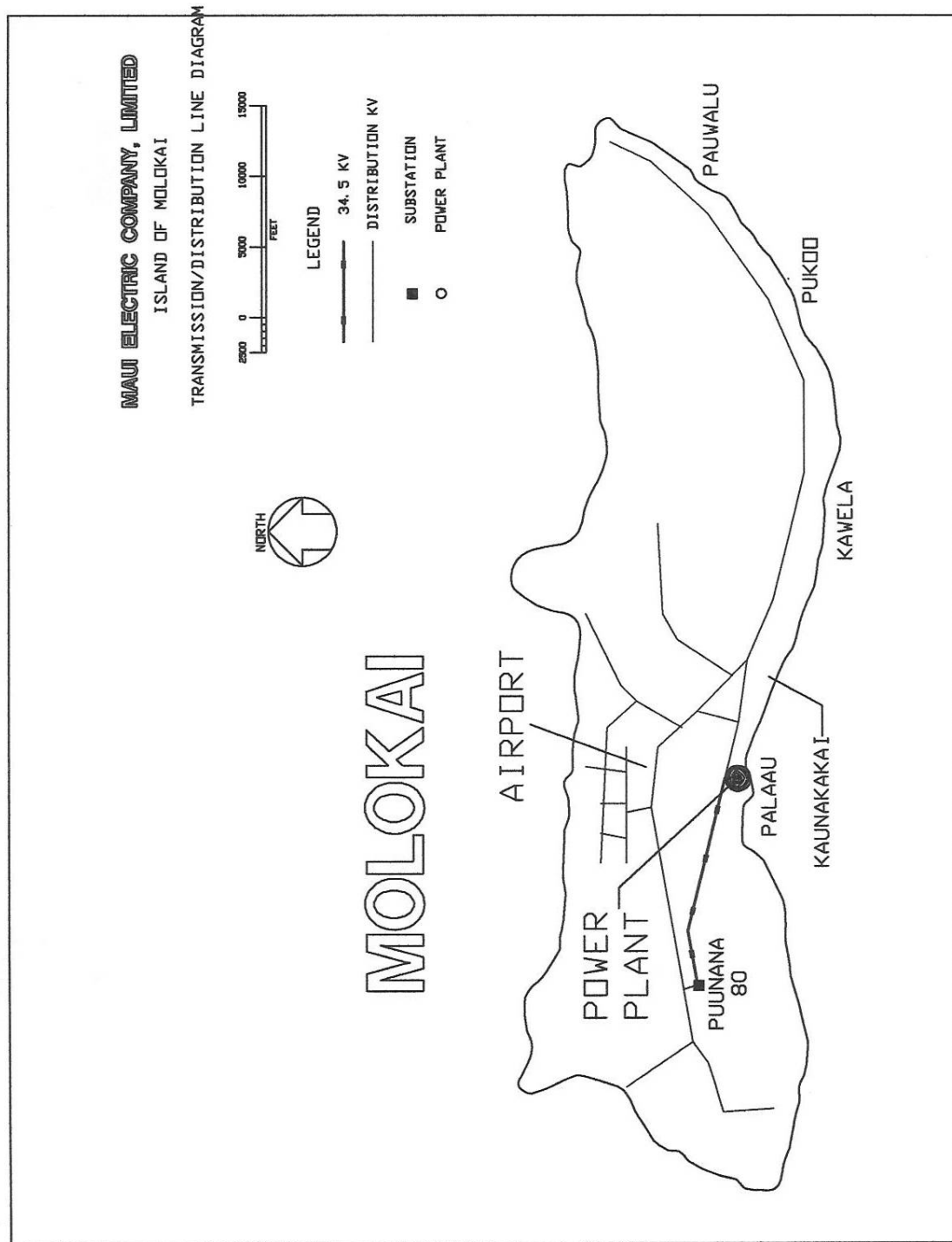
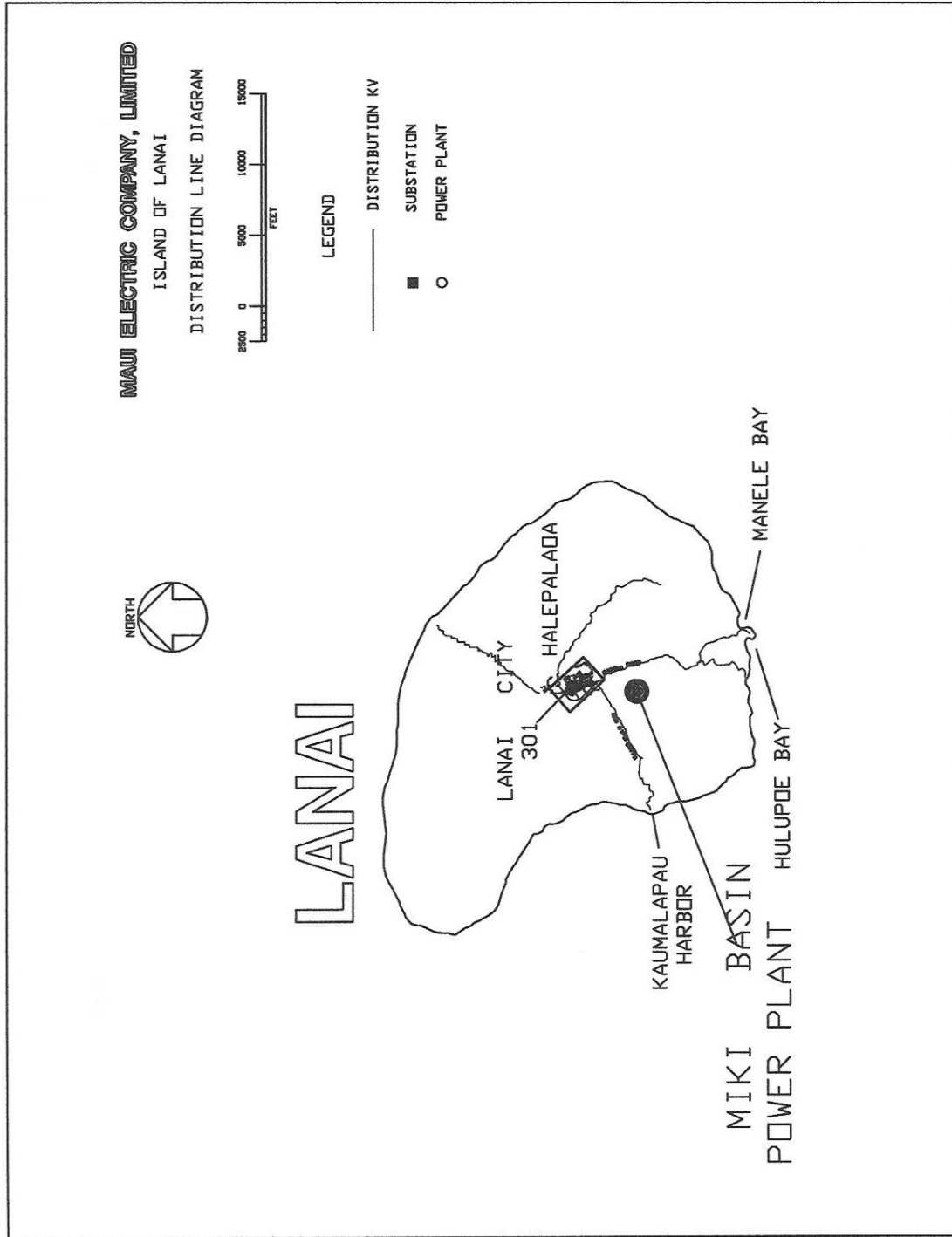


Figure A-3

Lanai Transmission Line Diagram



APPENDIX 4: GENERATING CAPACITY VERSUS ELECTRICAL DEMAND

The following graphs were generated in Section V. B. of this report. They are plotted against the future generating capacity plans of MECO. If both the generating capacity and the electrical demand follow the predicted pattern, the generating capacity will be able to meet future electrical demands in a safe and reliable manner.

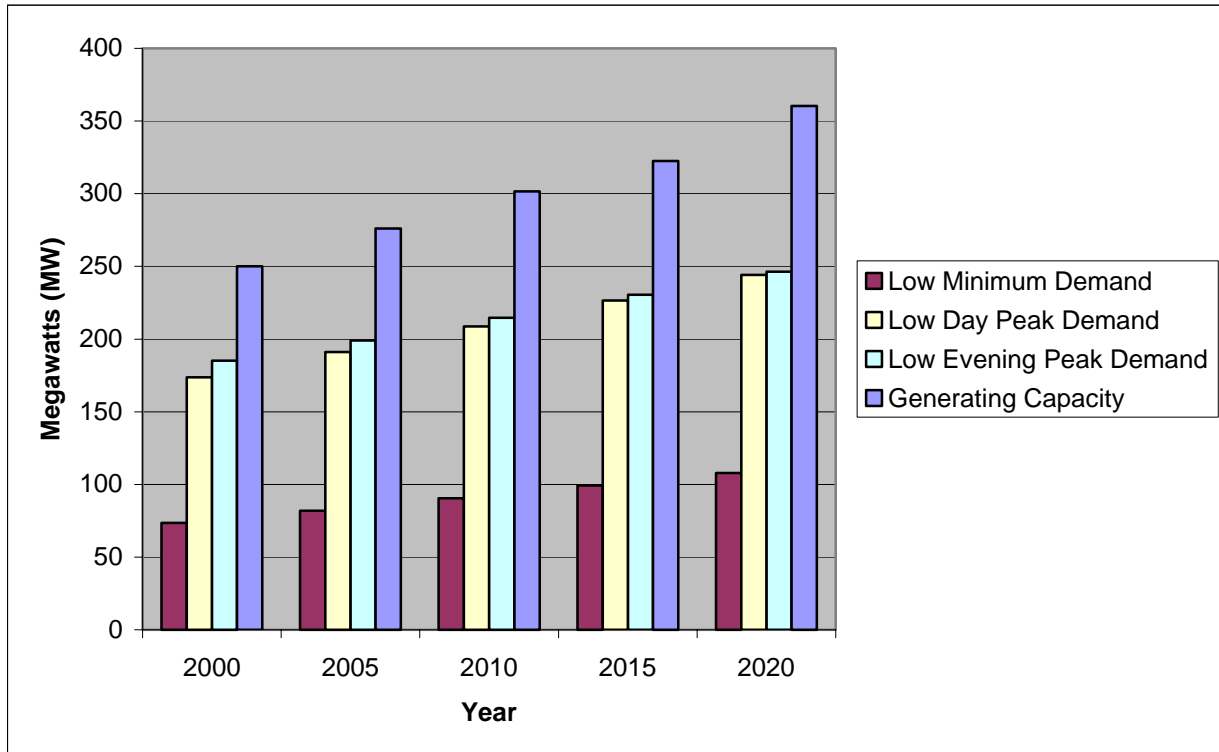
Figure A-5**Low Electric Demand Versus Future Generating Capacity**

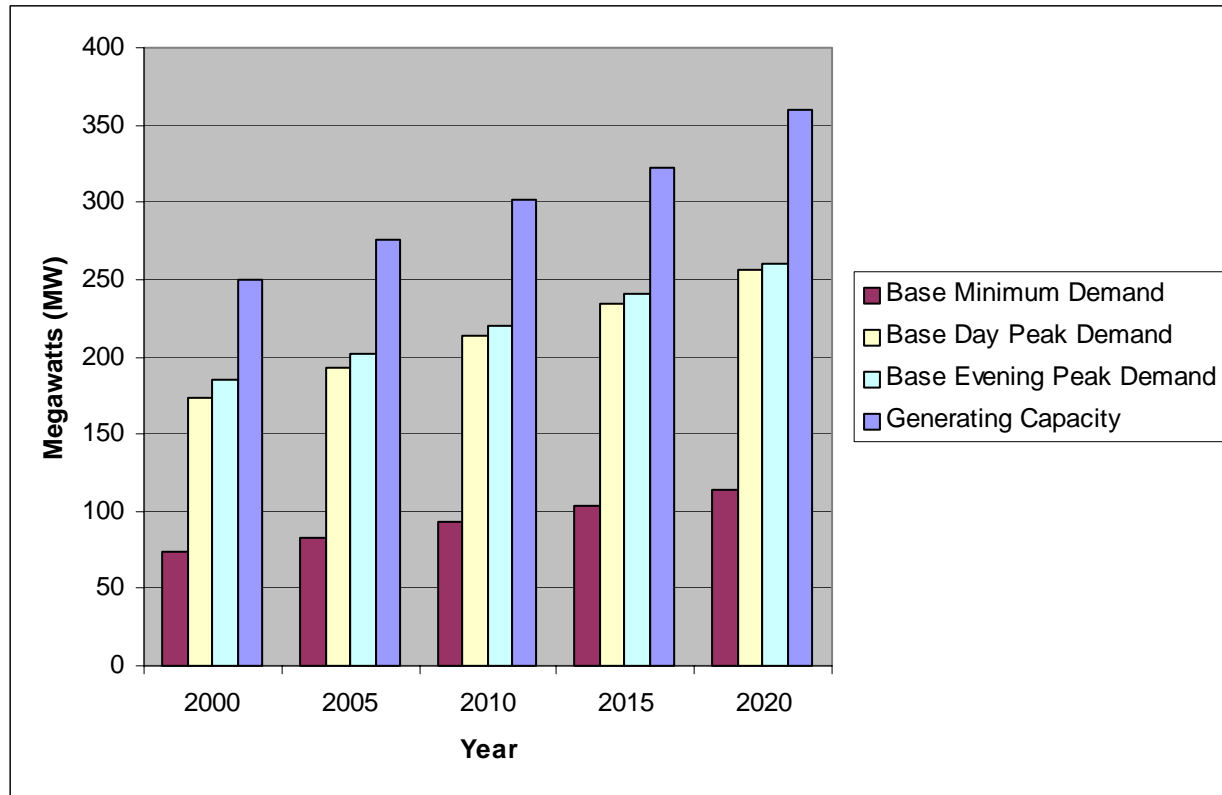
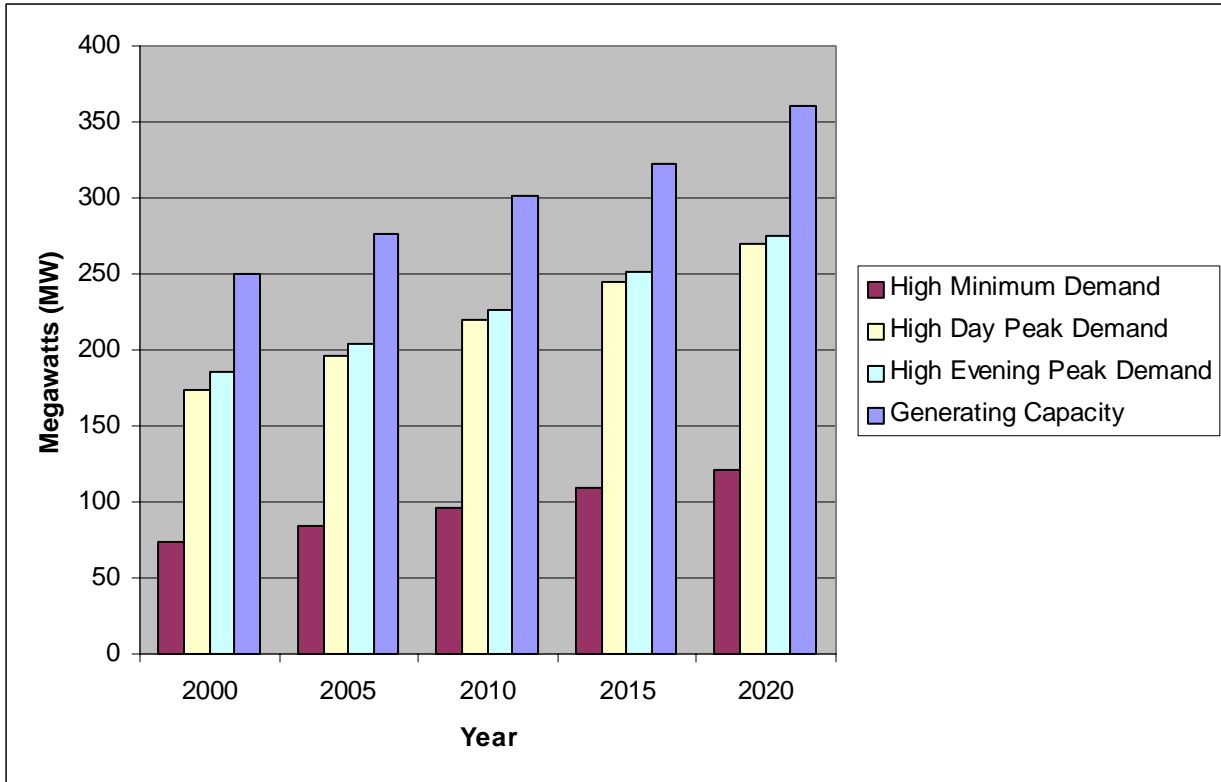
Figure A-6**Base Electric Demand Versus Future Generating Capacity**

Figure A-7

High Electric Demand Versus Future Generating Capacity

VI. INTRODUCTION – COMMUNICATION SYSTEMS

This section presents an assessment of the existing communication systems within the County of Maui. Both telephone and cellular communication service are provided by Verizon Hawaii while other private companies such as AT&T Wireless, Nextel, Sprint, and T-Mobile provide cellular telephone service. These companies are regulated by the State Public Utilities Commission (PUC).

Inasmuch as the County's role in the provision of this service is limited, this report is intended to provide an overview of major planning issues concerning telephone service on the islands as opposed to specifying needed improvements.

The availability of information and data, however, provided by these utilities have been limited and restricted since September 11, 2001. As a result, the information covered by this section is considered of a general nature.

Since the last assessment, exponential growth and development of digital technology and techniques has occurred in the communication industry.

VII. EXISTING FACILITIES

The telephone system can be envisioned as servicing three distinct clientele. The first sector is the domestic or household sector, the second is the commercial or business client and the third segment is the cellular phone user. Both businesses and residential consumers seek mobility and wide area coverage at a reasonable cost.

Due to heightened security and the highly competitive nature of this industry, data on these three segments were limited. The data for the residential and commercial customers was provided by Verizon through their filing with the Public Utilities Commission. Information on the cellular system was also via public sources.

The existing telephone system on Maui consists of a network of telecommunication links comprising of wire, fiber-optic, and microwave transmissions lines. Major switching nodes are located within the nine "Central Offices" on the island as well as the "Toll Office" in Wailuku. Radio communication stations provide microwave links off of the island, including a link which connects Hana with the rest of Maui via Huehue on the island of Hawaii and Haleakala.

Verizon Hawaii has been meeting the growth in demand for telephone service on Maui.

Cellular telephone coverage is provided for most areas of Maui, Molokai and Lanai by Verizon Wireless, AT&T Wireless, and Nextel. Sprint PCS has network coverage in Wailuku-Kahului, UpCountry, Kihei and Lahaina. T-Mobile has coverage in Wailuku-Kahului, Kihei, and Lahaina.

VIII. FUTURE COMMUNICATION SYSTEM

The statewide line demand and customer line gain growth has been projected to average 0.85% per year through 2006. The number of actively used lines provides an indicator of the intensity of use currently experienced by the system. The ratio of telephones in service to access lines are not currently in service is an indicator of the immediate expendability of the system.

Expanded use of internet access by residential and commercial telephone users have led to a change in usage factors by placing a greater burden on the system for a longer period of time than previously projected.

The movement toward higher speed internet accessibility has moved customers from a wire based telephone system to the use of broadband wireless and cable. This will impact the revenue base of the telephone systems.

Further use of wireless communications will also impact the demand for wire based telephone lines to residential and small business customers. The movement is toward a more active communication based paradigm affording internet and information access, email, and communication.

The residential and commercial telephone system on Maui currently has no apparent major limitations that severely impact voice service or quality.

One concern is the rapid rate of technological change, as the hardware used in a telecommunications system becomes technologically obsolete prior to physical obsolescence. In order to take advantage of the more efficient newer technologies the equipment in the system must be constantly upgraded. Nevertheless, strict industry performance standards have minimized component and system incompatibility.

Since much of the equipment removed from the system is still operationally sound, resale of this equipment can reduce the impact to the customer from the installation of new devices. The decision to install a new piece of equipment or system requires an extensive in-depth evaluation process. First, an evaluation of the technical need for the system or equipment change must be completed. Second, a financial analysis evaluating the cost of the new device or system is undertaken. Finally, the availability of labor to install the device or system must be considered so that rapid deployment and installation of the equipment with a minimum of service disruption is required.

IX. INTRODUCTION - CABLE

Oceanic–Time Warner Cable, a division of AOL–Time Warner, provides cable television service for the County of Maui. The company has built, maintained and operated cable systems for over 20 years. Oceanic–Time Warner Cable is also regulated by the State Department of Commerce and Consumer Affairs Cable TV Division.

Inasmuch as the County’s role in the provision of this service is limited, this section is intended to provide an overview of the major planning issues concerning cable television service on the island.

X. RESIDENTIAL AND COMMERCIAL DEMAND

A study performed by Oceanic–Time Warner Cable in 1996 accounted for 56,503 residential and commercial addresses, where cable service was available. The present customer count is at 62,757. This places the growth rate of potential cable customers at approximately 11%, over the last six years.

This growth rate is attributed to both the expanding population on Maui and the corporate posture of AOL–Time Warner in serving areas that were left un-served by the former cable providers. Table 5 lists the breakdown of potential customers by area.

Table 5

Potential Customers

AREA	CUSTOMER COUNT
Lahaina	14,757
Wailuku	16,615
Pukalani	12,919
Kihei	17,714
Hana	692

Note that the customer counts are somewhat evenly distributed among the major population areas. There is a small difference in the Pukalani count that reflects a more “rural” population density while the larger disparity in the Hana numbers represents Hana’s more isolated locale.

Oceanic – Time Warner Cable has earmarked Lahaina, Wailuku, and Kihei as areas of rapid growth but has also planned for additional customers in Pukalani and Hana.

XI. EXISTING SYSTEM

A. Design

In 2001, Oceanic–Time Warner Cable completed an upgrade of the existing cable system on Maui. The system upgrade adhered to the Time Warner Hybrid Fiber Coax (HFC) design parameter. The system utilizes a fiber optic trunk, a fiber optic distribution network and coaxial cable for final service to customers.

The system is a state-of-the-art 750 MHz, two-way platform capable of carrying services that include an expanded number of analog channels, digital programming, high-speed data access, and future services projected by the cable industry to satisfy consumer demands.

The basic premise of the design is to divide customers into 500 home “pockets” or serving areas (SA’s). Each SA has on optic to RF converter (node). These nodes are then fed via optical fiber from a hub. Each hub is capable of serving 40 SA’s or 20,000 customers. Hubs are expandable simply by the installation of additional equipment. Signals are passed between hubs via an optical “super trunk”.

Unlike phones systems that require dedicated lines for each individual user, cable service provisions service for all addresses that are passed by sharing a single, coaxial distribution cable. Discrete frequency allocation is then performed to allow customers a “virtual” dedicated link back to the hub. (This is how the high-speed data access service, like Road Runner, is achieved.)

B. Facilities

There are currently 4 hubs operating on Maui. The hub areas include Lahaina, Wailuku, Pukalani, and Kihei and mirror the customer distribution listed above. Hana is currently fed via microwave link between Hana and Puu Nianiau (on Haleakala).

Similarly, both Lanai and Molokai are served via a microwave link originating in Lahaina. (Geographic limitations favor a microwave connection rather than a fiber connection more attractive for these areas.) The current Lahaina microwave facility serving Molokai and Lanai will be relocated within the next 5 months (by June 2003). Oceanic–Time Warner Cable is currently processing the necessary permits to rebuild the facility at an alternate site.

A system map (Exhibit A) shows major fiber trunk and microwave paths. Distribution fiber is not displayed.

On Maui, there are 136 serving areas designed in line with the Time Warner HFC platform. Fiber is also in place for a relatively easy conversion to a “fiber rich” architecture that reduces the SA count from 500 homes per node to 250 homes per node. This conversion would only

occur should advanced services use all available bandwidth. Evolving technology in multiplexing makes this highly unlikely at this time. However, the infrastructure is in place.

Further, when larger distribution fibers are installed, considerations are made for planned new housing projects and potential projects based on current zoning assignments.

C. Capacity

Oceanic–Time Warner Cable has always positioned itself to react to the needs of its subscribers. Unlike utilities, consumers have a choice for cable television services.

Point-to-point microwave providers and satellite companies have stepped up their efforts to penetrate the Hawaii marketplace. A migration of subscribers from cable to these other service providers is being experienced.

Oceanic–Time Warner Cable is poised to provide timely service to meet the consumer demand. The current hubs can accommodate an additional 17,000 new subscribers. Distribution fiber cables have been placed in anticipation of serving new housing projects. Hub expansion occurs simply by adding additional equipment. Additional hubs or mini-hubs may be “dropped” along the fiber trunk should this need arise.

XII. CONCLUSIONS - CABLE

Oceanic–Time Warner Cable has expended \$12M to complete the upgrade of the cable facilities and system on Maui. The planning process focused on the provisioning of advanced services to current as well as future subscribers.

Infrastructure changes and additions, made at that time, took into account system expansions without significant changes to the system. The current capacity is projected to support similar, historic growth beyond the next decade.

Should growth exceed expectations, the present infrastructure has the flexibility to accommodate additional subscribers without major additions. Oceanic–Time Warner Cable is committed to provide state-of-the-art cable service to the residents of Maui for the duration of their cable franchise. The current system platform in place is geared toward that commitment.

